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Assessment of the 4X Cod Fishery in 1985

by

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Abstract

For the third year in a row, the 30,000 t TAC for 4X cod was not caught; the 1985 nominal catch was 21,379 t. Small otter trawlers (TC 2 & 3) were the only gear category to reach or exceed their allocation. The presence of dogfish may be partially responsible for the reduced landings by longliners. Interpretation of commercial catch rates was complicated by probable misreporting problems and the multispecies nature of the fishery. Nevertheless, catch rates for both OTs and LLs have declined substantially since the late 1970s. In contrast, RV surveys suggest relative stability in numbers and biomass through the same period. An extended catch-at-age matrix (1948 - present) was developed in order to facilitate calibration of the SPA and to provide an historical perspective on recent events in the cod population. Cohort analysis of the extended matrix indicates that the fishery has a long history of overexploitation. Calibration of the most recent years of the analysis was complicated by the relative stability of the RV population. However, a terminal F of 0.40 (selected with the correlation coefficient as the tuning criterion) was consistent with that estimated by the Survivor model (0.38). This estimate is probably a minimum one; mean weight in the catch, the time series of fully-recruited Fs, and a recent decline in SPA fishable biomass all suggest that F_t = 0.40. may underestimate the actual terminal fishing mortality. If the 1986 TAC of 20,000 t is caught, the projected $F_{0.1}$ catch for 1987 is 13,000 t.

Résumé

Pour la troisième année consécutive le TPA de 30 000 t pour la morue de 4X n'a pas été atteint; les captures nominales pour 1985 s'élevaient à 21 379 t. La part assignée des captures n'a été atteinte ou dépassée que dans le cas d'une seule catégorie d'engins de pêche, soit les petits chalutiers (CT 2 et 3). La présence d'aiguillats peut en partie expliquer les arrivages réduits dans le cas des palangriers. L'interprétation des taux de captures commerciales a été compliquée par des problèmes de rapports probablement inexacts et par la nature de cette pêche qui implique des captures de plusieurs espèces. Néanmoins les taux de capture, tant par les chalutiers que par les palangriers, ont diminué de manière substantielle depuis la fin des années 1970. Par contre les relevés par les navires de recherche suggèrent une relative stabilité en nombres et en biomasse pour la même période. L'on a dressé une matrice étendue (1948 à aujourd'hui) des captures en fonction de l'âge afin de faciliter l'étalonnage de l'ASP et de mettre en perspective les événements récents de l'évolution de la population de morues. L'analyse par cohortes appliquée à la matrice étendue indique une surexploitation historique dans le cas de cette pêche. L'étalonnage pour les dernières années sur lesquelles a porté l'analyse a été compliqué par la relative stabilité de la population telle que relevée par les navires de recherche. Toutefois un F final de 0,40 (choisi en utilisant le coefficient de corrélation comme critère d'ajustement) est compatible avec celui estimé au moyen du modèle des survivants (0,38). Cette estimation constitue probablement un minimum; le poids moyen des captures, la succession chronologique des valeurs F de plein recrutement et une diminution récente de la biomasse exploitable d'après l'ASP suggèrent tous qu'une valeur F de 0,40 peut sous-estimer la mortalité finale réelle due à la pêche. Si le TPA de 20 000 t pour 1986 est atteint, les captures projetées à $F_{0,1}$ pour 1987 s'élèveraient à 13 000 t.

Introduction

Assessment of the 4X cod fishery continues to be complicated by the presence of several resident stocks (Templeman, 1962; Gagné et al., MS 1983; Campana and Simon, MS 1984). Cod from Georges Bank may also migrate into the area (Wise, 1963). In 1984, an analytical approach to the assessment of the entire 4X cod fishery was justified on the basis of evidence of stock mixing, exploitation by a highly mobile fleet and the ability to better quantify fishery effects through such an approach. The current assessment is again analytically based. However, preliminary results from major offshore tagging studies indicate that 4X stock structure may be more homogeneous than was previously suspected: tagged offshore fish have been recovered inshore in significant numbers (W.T. Stobo, pers. comm.). These results suggest that even if separate assessments for offshore and inshore stocks were feasible (Halliday, MS 1974), they may no longer be appropriate.

Last year's assessment (Campana and Simon, MS 1985) was hampered by the relatively short time series of data that was then available. This situation has been rectified through extension of the catch-at-age matrix back to 1948. In addition to facilitating the calibration of the SPA, the extended matrix provides a historical perspective on recent events in the cod population.

Nominal Catches

Historically, the cod fishery in 4X (Figure 1) has been prosecuted by a Canadian inshore fleet. Between 1947 and 1961, total landings for the Division averaged 15,000 t, with less than 3,000 t estimated as having come from the offshore grounds. The introduction of large foreign trawlers in 1962 resulted in a rapid increase in catches, which peaked at 35,500 t in 1968 (Table 1). Imposition of quotas on 4X haddock by ICNAF in 1970 substantially reduced cod catches (to approximately 22,000 t), emphasizing the by-catch nature of many cod landings. Since 1976, the fishery has been essentially 100% Canadian and landings increased to almost 32,000 t; however, there has been a marked decline in landings since 1982 (Figure 3). The 1985 nominal catch was 21,379 t.

Small (TC2-3) otter trawlers (OT) substantially exceeded their allocation in 1985, the only gear category to have done so (Table 2). This gear sector has misreported 4X cod to 5Y in previous years (documented in Campana and Simon (MS 1985)), necessitating adjustment of reported landings. Since misallocation was also apparent in 1985 (Table 3), adjustments have again been made. A breakdown of landings by gear, tonnage class, and unit area over recent years is presented in Table 4. As indicated in Figure 4, catches peaked in the summer months. Landings were split between draggers and fixed gear, but for the first time since 1970, the former took the largest proportion of the domestic catch. Catches by TC-1 vessels accounted for 35% of the total, considerably lower than in past years. Much of this decline is attributed to reduced catches by longliners, who in turn have blamed dogfish and aberrant temperature

conditions for their reduced effort. While there is little evidence of temperature anomalies (Drinkwater and Trites, MS 1986), dogfish abundance appears to be at a record high (Annand, MS 1985).

Stock Abundance Indices

Commercial Catch Rates

Catch rates for 4X cod were calculated for six gear/TC categories (4-LL; 2-OT) selected on the basis of available effort data. Catch rates were calculated on a quarterly basis and then standardized. Standardization was conducted through normalization of the mean post-1976 catch rate within a given gear/quarter; yearly values were then averaged across gears. The results indicated that the strong downward trend noted in the last assessment was continued into 1985 (Table 5; Figure 5). This trend was consistent among gear types, although it may have had multiple origins. The decline in LL catch rates partially reflects the increased abundance of dogfish in 4X (Annand, MS 1985). In addition, discussions with fishermen suggest that the decline in OT catch rates is partly an artifact of misreported catches in log books. Such a suggestion is consistent with the misreporting documented in Campana and Simon (MS 1985) and the increased catchability coefficient associated with the use of the Rockhopper trawl. For the above reasons, commercial catch rates may not be an accurate index of abundance for 4X cod.

Research Vessel Surveys

Random stratified surveys of the Scotian Shelf have been conducted since 1970; Strata 70-95 comprise the offshore and Bay of Fundy region of 4X (Figure 2). Inshore regions are not surveyed due to the prevalence of rough bottom. Surveys between 1970 and 1981 were carried out by the A.T. Cameron, while the Lady Hammond was used in 1982 and the Alfred Needler in subsequent years. As per the recommendation of the Statistics, Sampling and Surveys Subcommittee of CAFSAC, no inter-vessel conversion factors have been applied. All RV data have been presented in terms of Alfred Needler trawlable units (34' wingspread).

Age-structured survey population estimates are presented in Table 6a. Table 6b presents the same data adjusted to the beginning-of-the-year (through within-cohort geometric means of adjacent years). While 5+ numbers fluctuated in the early 1970s, subsequent years suggest relative stock stability in terms of the numbers (Table 6; Figure 6) and only a slight decline in biomass (Table 7; Figure 7). Relative stability is reflected in the fact that beginning-of-the-year 5+ numbers have varied by less than a factor of 2 over the time series. The low variability in turn restricts the utility of RV data for the SPA calibrations that follow. Note that the RV weight- at-age data in Table 7 are approximate values only, since they are unweighted by stratum area. The 1982 and 1983 year-classes have appeared strong in both the 1984 and 1985 surveys, and may thus represent good incoming recruitment.

Age Composition of the Catch

In the last assessment, quarterly age-length keys were computed for each of the major gear types (pooled among tonnage classes) for the period 1977-84. Forty samples went into the construction of the 1985 keys. However, to facilitate the calibration of the SPA, an extended catch-at-age series was necessary. The extended series was provided through computation of quarterly keys from 1948 to the present. Based on the results of a Monte Carlo simulation model (Appendix), historical sampling intensity was deemed adequate for all but a couple of years in the time series (Table 8b). Where coverage was incomplete, the following hierarchial aggregation policy was followed for missing age composition cells:

a) apply mean for gear/year;
b) apply mean from same gear and adjacent quarters, adjusting for age differential if samples originated in different years;
c) apply LL sample to missing GN cell; and
d) apply mean for year irrespective of gear.

Since this aggregation policy differed slightly from that applied last year (Campana and Simon, MS 1985), modest changes in the catch at age for the period 1977-84 were incurred. These changes were on the order of a few percent (Table 12).

Sample aggregation was generally unnecessary for major landings, except for several years in the late 1960s. Missing weight-at-age cells were left blank, except for calculation of fishable biomass where within-cohort means from adjacent years were used. Missing sample weight cells were treated as described for age composition with the exception of stage (d); there, mean sample weights from the same gear/quarter and adjacent years were applied. Length-weight relationships were derived from seasonal RV data; in years where a survey was not conducted, seasonal means were applied.

Quarterly landings data and sample information are presented in Table 8. Since landings by each gear type between 1948-53 were reported only on an annual basis, quarterly landings were calculated using the mean seasonal distribution in the years 1954-56. This approach was justified by the relative stability in catch seasonality through the years. Large shifts in landings between LL and miscellaneous gears in the 1950s appear to be an artifact of changes in statistical reporting criteria. Numbers at age for each of the major gear categories are presented in Table 9. Catch numbers-at-age for the miscellaneous gear category was computed quarterly, through a pro-rated comparison of miscellaneous landings with the sum of OT, LL and GN landings. Foreign catches were treated similarly, but were pro-rated only on the basis of OT landings (since all foreign catches employed trawl gear).

Total catch numbers and percent catch numbers-at-age are presented in Table 10. A comparison of the 1985 catch composition and that predicted last year for 1985 indicates that fully recruited ages (5+) were better predicted than were the younger years (Figure 8). Although the discrepancy was small, either partial recruitment or the size of the year-classes must have been overestimated. Fish aged 3-5 made up the largest proportion

of the catch numbers while ages 4-6 made up most of the catch weight (Table 11) in 1985. Catch composition curves indicate that age 5 fish were fully recruited to the fishery. Temporal trends in mean catch weight-at-age (Table 13) were at least in part due to shifting gear emphasis through the time series.

Estimation of Stock Size

Survivor

As an index of terminal F for SPA calibration, the program Survivor has performed well in "a posteriori" analyses (O'Boyle et al., MS 1984; Gagné et al., MS 1984). Survivor was run on 4X cod using a calibration block of 1972-84 (ages 2-7) and full recruitment to the survey gear at age 6. The results are presented in Table 14. Terminal F on 5+ fish was calculated as 0.38 which differs only slightly from the Survivor value calculated in the 1984 assessment. The low CVs suggest an excellent fit of the model to the data. To determine if the Survivor model's constraint of a fixed origin influenced the results, RV and Survivor population correlations were examined on an age by age, unconstrained basis. The constrained and unconstrained relationships were similar, indicating the absence of an influence. Two of the three outliers in the Survivor output were associated with the 1975 survey; as will be seen later, these points indeed seem to be anomalous.

Cohort Analysis

Cohort analyses were run on ages 1-13 in the catch-at-age matrix in Table 10. Natural mortality was set at 0.2 and the age of full recruitment at 6. Fishing mortality on the oldest age group was a weighted mean (weighted on population numbers) of F's on the fully recruited age groups. Partial recruitment (defined as F ÷ weighted mean of fully recruited Fs) in the final year was set at the mean of the years 1980-84; the partial recruitment of age 5+ fish in 1984 was set at 1.0. Cohort runs were conducted for terminal Fs of 0.2-0.8 at 0.05 intervals.

Calibration of the SPA

Calibration of the cohort runs was difficult in view of the relative stability in the RV survey estimates since 1972; this resulted in a narrow range of values through which the regression was calculated. While age-by-age, age 4-6 and age 5+ tuning was attempted, regressions were insignificant at all levels of F_t. However, 1975 values were outliers in all of the relationships (Figure 9). Given the results of the Survivor analysis, the 1975 data were treated as an outlier and removed. The result was a significant regression at F_t = 0.40 (Figure 10). The tuning criterion was the correlation coefficient. Assumptions of linearity and a normal distribution of residuals were tested and deemed acceptable (Figure 10). The decision to use the SPA population estimate as the dependent variable was based upon a comparison of variances in the commercial catch-at-age and RV catch-at-age matrix (Table 20). While CVs in the latter exceeded those in the former, the commercial catch-at-age CV data

almost certainly under-estimated those to be found after completion of an SPA. Until SPA variances can be calculated, we have assumed that they exceed RV variances and that the dependent variable should be considered to be the SPA estimate.

Commercial catch rates were also used in calibration. The mid-year SPA fishable biomass was calculated as

$$(POP \times e^{-(F+M)\times.5}) \times \text{mean weight} \times \text{partial recruitment}$$

for each cohort run. Mean partial recruitment-at-age was used for the intervals 1948-56, 1957-65, and 1966-85 (since no temporal trends were apparent in intra-interval PRs). Partial recruitment was set to 1.0 for all fully-recruited ages. Fishable biomass was tuned against the standardized pooled catch rate, the standardized LL catch rate and the standardized OT catch rate. All of these relationships were similar in that all were statistically insignificant. Given the caveats expressed earlier concerning the accuracy of the CPUE data, such a result was not surprising.

Calibration of the cohort run against RV data produced estimates of F_t in the order of 0.40 - 0.45. This range is consistent with that estimated from Survivor (F_t=0.38). Ancillary information also suggests that F_t is at this level or higher. The time series of fully recruited Fs indicates that a 1985 F_t of 0.40 would be among the lowest in 30 years (Figure 11a). Fishable biomass has been declining since 1980 (Figure 11b). Further, the observed mean weight in the catch lies far below that expected of overfishing at F_{max}, let alone $F_{0.1}$ (Figure 12). For this reason, an F_t of 0.40 was considered to be a minimum estimate for 1985. The corresponding cohort run is presented in Tables 15-17. Partial recruitment values are indicated in Table 18.

Yield Per Recruit

Yield per recruit was calculated in three ways: using 1985 population parameters, using the mean of 1981-85 weights at age, and using the mean of 1948-85 weights-at-age and PR. All produced similar results (Table 19). $F_{0.1}$ was calculated as 0.16-0.17, F_{max} as 0.27-0.29, and $F_{0.1}$ yield per recruit as 1.03-1.11.

Recruitment of 4X cod has varied by a factor of 6 between 1948-84 (Figure 13). Long-term yield of 4X cod was estimated from the geometric mean of age 1 recruitment through this period ($20,052 \times 10^3$). Expected annual yield (long-term) at $F_{0.1}$ is 21,000 t. This value is somewhat lower than that reported last year, due largely to the improved (and lower) estimate of long-term, mean recruitment to the stock.

Catch Projections

Catch was projected to 1987 using 1985 weights at age, the mean of the 1980-84 partial recruitments (at F_t = .40), and a GM value for age 1 recruitment (Table 21). For 1986 the catch was assumed to be at 20,000 t (1986 Management Plan) yielding a 1987 $F_{0.1}$ (= 0.20) catch of 13,000 t (Table 22).

Conclusions

Prior to 1985, assessments of stock well-being suggested that the 4X cod fishery was overexploited (Halliday, MS 1971, MS 1974; Sinclair, MS 1980; deLafontaine, MS 1981; Gagné et al., MS 1983; Campana and Simon, MS 1984). This view of the fishery was substantiated in 1985 when the first analytical assessment of the 4X stock complex was presented (Campana and Simon, MS 1985). In the present document, extension of the SPA back to 1948 reveals that the fishery has a long history of overexploitation.

Fully recruited F values between 1948-85 have ranged as high as 0.82 with a long-term mean of 0.47. This value is well above the estimated F_{max} of 0.28, clearly indicating the resistance of 4X cod to heavy fishing pressure. That the fishery has persisted so long is testament to the rather persistent recruitment potential of the stock; it also suggests that the yield could have been much greater if overexploitation had not occurred.

Current assessments of stock well-being differ little from the long-term overview. Stock size, fishable biomass, terminal fishing mortality, and recent recruitment levels all approximate the long-term mean.

Evidence to suggest that stock size is now declining may be illusory. A decline in fishable biomass since 1980 is largely due to reductions in mean weight at age in the catch. This in turn may reflect shifts in gear emphasis in the fishery, although this hypothesis requires further investigation. Declining commercial catch rates are subject to misreporting problems and interference by dogfish; thus they may not be representative of true stock abundance. Conversely, both RV surveys and fully-recruited SPA numbers suggest relative stability in the population. Accordingly, we conclude that the 4X cod population is currently stable in numbers, albeit heavily overexploited.

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References

Annand, C. MS 1985. 1985 status report on 4VWX dogfish (Squalus acanthias). CAFSAC Res. Doc. 85/73.

Campana, S. and J. Simon. MS 1984. The 4X cod fishery: A biological update. CAFSAC Res. Doc. 84/43.

Campana, S. and J. Simon. MS 1985. An analytical assessment of the 4X cod fishery. CAFSAC Res. Doc. 85/32.

de Lafontaine, Y. MS 1981. 1981 analyses of offshore cod stock in Division 4X. CAFSAC Res. Doc. 81/45.

Drinkwater, K.F. and R.W. Trites. MS 1986. Overview of environmental conditions in the Northwest Atlantic in 1985. NAFO SCR Doc. 86/72.

Gagné, J.A., L. Currie, and K. Waiwood. MS 1983. The offshore cod fishery in 4X: A biological update. CAFSAC Res. Doc. 83/43.

Gagné, J.A., A.F. Sinclair, and C. Dale. MS 1984. The 1984 assessment of 4VsW cod: A completely revised procedure. CAFSAC Res. Doc. 84/78.

Halliday, R. MS 1971. A preliminary report on an assessment of the offshore cod stock in ICNAF Div. 4X. ICNAF Res. Doc. 71/12.

Halliday, R. MS 1974. A virtual population assessment of the Division 4X offshore cod stock. ICNAF Res. Doc. 74/25.

O'Boyle, R., J. McMillan, and G. White III. MS 1984. The 4X haddock resource: A problem in supply and demand. CAFSAC Res. Doc. 84/100.

Sinclair, A. MS 1980. Research survey population estimates for 4X offshore cod. CAFSAC Res. Doc. 80/46.

Templeman, W. 1962. Divisions of cod stocks in the northwest Atlantic. ICNAF Redbook III: 79-123.

Wise, J.P. 1963. Cod groups in the New England area. Fish. Bull. 63: 189-203.

Table 1 . 4X cod nominal catches (t) by country (1948-85).

Year	Canada M&Q	Canada NLFD.	Spain	USSR	USA	FRG	France	Japan	Other	Total	% Canada
1948	17761				1999					19760	89.9
49	14282				1799					16081	88.9
1950	19088				1581					20669	92.4
51	16543				1639					18182	91.0
52	16570				1651					18221	90.9
53	12903				1461					14364	89.8
54	14406				2523		19			16948	85.0
55	13432				1378					14810	90.7
56	14849				1663					16512	89.9
57	13619				1083					14702	92.6
58	11103				1110					12213	90.9
59	12866				862					13728	93.7
1960	12123				1605					13728	88.3
61	12424		2	9	1263					13698	90.7
62	14656		3	80	1157					15896	92.2
63	15849		1	684	1301	9				17844	88.8
64	20767			2922	1413	338			15	25455	81.6
65	24221		144	1553	871	125				26914	90.0
66	24244		803	4961	966				5	30979	78.3
67	27813		2536	667	1445					32461	85.7
68	30770		2829	1061	859		24			35543	86.6
69	24056		8217	1	448		3		1	32726	73.5
1970	18001		3647	10	499			152		22309	80.7
71	20180		2615	337	239			6		23377	86.3
72	20490		1547	30	323	2				22392	91.5
73	20002		1519	562	136			5		22224	90.0
74	19005		1640	119	385	15	5		2	21171	89.8
75	19493		900	207	480	3			5	21088	92.4
76	16138		175		339				3	16655	96.9
77	22002			4	760		185			22951	95.9
78	23719	10		6	276	2		3	1	24017	98.8
79	28647	28			46			1		28722	99.8
1980	30735	355	2	94	75			10	6	31277	99.4
81	31043	47			125			5		31220	99.6
82	32701	9			234			1		32945	99.3
83	28963			11	286			1		29261	99.0
84	25068			5	189					25262	99.2
85	21370				9					21379	100.0

Sources: 1948-53 ICNAF Suppl. Ann. Proc. 11 (Appendix) (1962).
1954-66 NAFO Statistical Bulletins
1967-85 MFD Statistics

Table 2. Canadian quota allocation and reported Maritime landings by gear category for cod in 4X and 5Y. Landings are derived from Atlantic quota reports (FG = fixed gear; MG = mobile gear).

		4X		5Y	
Year	Gear	Allocation	Reported Landings	Allocation	Reported Landings
1981	All gear	Unlimited	30742	192	599
1982	All gear	30000	31520	200	871
	FG < 65'	20250	20505	/	/
	MG < 65'	6000	7942	200	871
	FG 65-100'	200	168	/	/
	MG 65-100'	400	150	/	/
	> 100'	3150	2494	/	/
1983	All gear	30000	25610	1500	2578
	FG < 65'	20250	14892	700	176
	MG < 65'	8000*	9167	700	2394
	FG 65-100'	200	54	/	/
	MG 65-100'	400	192	/	/
	> 100'	3150	1305	100	8
1984	All gear	30000	24088	1500	1404
	FG < 65'	20250	12206	700	164
	MG < 65'	6000	10201	700	1240
	FG 65-100'	200	5	/	/
	MG 65-100'	400	88	/	/
	> 100'	3150	1588	100	0
1985[1]	All gear	30000	20810	1500	1474
	FG < 65'	17000	9843	500	78
	MG < 65'	8900	9683	900	1392
	FG 65-100'	200	6	/	/
	MG 65-100'	400	38	/	/
	> 100'	3500	1240	100	4

* adjusted in mid-year
1 Preliminary

Table 3. Adjustment of OT (TC 2, 3) nominal catches in 4X to reflect misreported catches in 5Y (as justified in Campana and Simon 1985).

Year	Reported		Adjusted	
	4X	5Y	4X	5Y
1977	4777	106	4883	0
1978	4018	380	4398	0
1979	4096	340	4436	0
1980	6786	161	6947	0
1981	5731	300	6031	0
1982	6409	1180	7589	0
1983	8396	2562	10958	0
1984	7554	2905	10459	0
1985	8320	1363	9683	0

Table 4. Nominal catch (t) of 4X cod in the Maritimes. Underlined catches represent the most dominant TC for a gear/unit area.

Year	Unit[B] Area	OTB* 1	OTB* 2	OTB* 3	OTB* 4	OTB* 5	LL / LHP[A] 1	LL / LHP[A] 2	LL / LHP[A] 3	LL / LHP[A] 4	GN 1	GN 2	Misc.	Total
1983	M	4	22	42	1	321	1339	257	187	/	1131	4	146	3454
	N	/	168	159	92	379	3	609	180	2	/	6	121	1719
	O	81	462	320	65	307	5962	365	140	3	725	141	126	8697
	P	/	1023	647	15	84	7	714	337	3	/	/	2	2832
	Q	234	828	1341	26	/	721	329	23	/	1	7	176	3686
	R	266	1334	2399	15	/	612	32	/	/	38	13	2	4711
	S	52	289	494	11	/	771	39	6	/	156	42	6	1866
	U	1	608	821	75	/	1	448	7	2	/	14	18	1995
	Total	638	4734	6223	300	1091	9416	2793	880	10	2051	227	597	28960
1984	M	/	17	26	2	315	762	395	124	/	536	12	77	2266
	N	/	190	269	34	1064	31	570	199	2	/	9	9	2377
	O	68	528	355	47	68	4282	391	59	/	392	140	67	6397
	P	4	244	399	/	66	178	560	386	/	/	/	/	1837
	Q	95	692	1148	14	/	540	56	41	/	4	/	175	2765
	R	235	1202	1774	/	/	562	8	/	/	2	/	2	3785
	S	119	423	391	/	/	421	14	1	/	179	43	27	1618
	U	/	901	1898	12	/	7	929	167	1	/	18	94	4020
	Total	521	4197	6260	109	1513	6778	2923	977	3	1112	222	451	25066
1985	M	/	42	62	8	530	641	224	76	1	1196	34	206	3020
	N	/	132	221	27	577	7	158	122	/	/	3	2	1249
	O	89	642	272	3	38	3731	288	40	/	392	24	46	5565
	P	/	227	506	1	29	3	272	92	/	/	/	/	1130
	Q	68	709	946	10	/	316	80	9	/	/	/	93	2231
	R	83	867	1324	4	/	305	/	/	/	3	/	22	2608
	S	101	553	435	/	/	317	1	/	/	192	49	/	1648
	U	/	1181	1564	/	12	7	789	245	/	/	55	69	3915
	Total	342	4353	5330	54	1185	5320	1813	585	1	1783	166	439	21370

* Catches misreported as being from 5Y have been allocated proportionally among OTB TC 2 and 3 vessels in 4X (see Table 3).

A LHP = handline

B See Figure 1 for location of unit area; U = unspecified.

Table 5. Commercial catch rates for otter trawlers (OT) and longliners (LL) in 4X (all unit areas combined). Effort values in parentheses. a) Effort units are hundreds of lines (LL) and tons/hr (OT); b) Effort is in terms of days fishing.

a)

	Gear					
Year	LL - TC2 Jan-Mar	LL - TC2 Apr-June	LL - TC2 July-Sept	LL - TC3 Jan-Mar	OT - TC2 Apr-June	OT - TC3 July-Sept
1973	1.47 (10)	1.71 (13)	1.05 (125)	1.91 (25)	/	/
1974	1.81 (73)	1.17 (203)	0.99 (171)	1.67 (180)	.10 (174)	/
1975	1.51 (87)	1.31 (256)	0.85 (153)	1.67 (102)	.15 (205)	.20 (173)
1976	1.10 (72)	1.00 (99)	0.76 (235)	1.38 (44)	.10 (716)	.15 (313)
1977	1.31 (258)	1.17 (284)	1.18 (224)	1.80 (169)	.17 (2576)	.35 (1159)
1978	1.59 (362)	1.18 (250)	1.11 (276)	2.19 (190)	.20 (1142)	.58 (1448)
1979	1.38 (262)	1.19 (320)	1.48 (291)	2.25 (143)	.28 (923)	.31 (897)
1980	1.27 (213)	0.93 (519)	1.03 (209)	1.75 (188)	.18 (4636)	.26 (1914)
1981	1.51 (412)	1.17 (310)	0.86 (138)	2.20 (168)	.22 (1947)	.23 (811)
1982	1.20 (670)	1.09 (424)	1.24 (416)	1.62 (329)	.14 (3074)	.25 (1997)
1983	1.26 (295)	1.29 (234)	0.79 (117)	1.70 (177)	.20 (5181)	.21 (2887)
1984	1.18 (294)	0.99 (145)	0.95 (33)	1.45 (207)	.12 (2574)	.24 (2780)
1985	1.30 (203)	0.86 (134)	0.81 (34)	1.42 (58)	.13 (3185)	.26 (3475)

b)

Year	LL - TC2 Jan-Mar	LL - TC2 Apr-June	LL - TC2 July-Sept	LL - TC3 Jan-Mar	OT - TC2 Apr-June	OT - TC3 July-Sept
1973	/	/	1.85 (71)	/	/	/
1974	3.50 (38)	2.19 (108)	2.06 (82)	4.12 (73)	/	/
1975	2.81 (47)	2.24 (150)	1.69 (77)	3.21 (53)	/	/
1976	2.14 (37)	1.87 (53)	1.64 (109)	3.20 (19)	0.88 (77)	1.27 (38)
1977	2.93 (115)	2.84 (117)	2.56 (103)	4.11 (74)	2.74 (165)	2.55 (157)
1978	3.85 (149)	2.48 (119)	2.18 (141)	5.02 (83)	2.07 (108)	5.31 (163)
1979	3.04 (119)	2.70 (141)	2.50 (173)	5.28 (61)	2.72 (94)	3.51 (78)
1980	2.74 (99)	2.16 (223)	2.02 (107)	4.11 (80)	2.86 (288)	3.27 (154)
1981	3.29 (189)	2.47 (147)	1.76 (67)	5.20 (71)	2.10 (208)	3.38 (56)
1982	3.52 (228)	2.41 (192)	2.58 (201)	4.77 (112)	1.83 (243)	2.86 (177)
1983	2.76 (135)	2.11 (143)	1.06 (87)	4.03 (75)	2.31 (455)	2.48 (240)
1984	2.49 (140)	1.85 (78)	1.43 (22)	3.37 (89)	1.15 (264)	2.41 (273)
1985	2.64 (100)	1.62 (71)	0.98 (28)	3.44 (24)	1.46 (290)	3.10 (300)

Table 6. Numbers at age ('000) in RV surveys of 4X cod. Surveys between 1970-81 were made by the A.T. Cameron, 1982 by the Lady Hammond, and 1983-85 by the Alfred Needler. All values converted to A.N. units. No inter-vessel conversion factors were used.

(A) Summer

STRATA 70-95 17/ 4/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	0	0	0	28	196	0	0	0	28	0	2197	74	88	164	0	84
1	1136	404	304	138	496	1294	171	383	239	3491	247	2671	877	169	971	597
2	1810	8481	1886	2652	1173	3162	1370	2845	1289	4521	1056	2903	2161	1290	6525	10554
3	2850	4713	3703	1405	5811	1863	2916	5101	2131	2259	3400	2738	2135	4971	4270	5070
4	5077	758	3293	2501	1346	3634	2398	3150	3101	2390	1365	3090	2238	2844	2959	1793
5	2232	1733	858	794	2256	2445	2221	931	1813	2078	1261	1619	1840	1770	2343	1830
6	2996	786	587	316	1211	1382	934	1476	648	1149	1716	1048	1053	1108	866	950
7	1266	1106	151	189	189	888	479	430	496	543	552	576	288	450	607	649
8	620	55	661	61	0	290	259	255	110	360	255	469	297	0	75	355
9	208	0	272	217	56	181	67	55	86	61	152	130	257	92	79	192
10	113	21	129	55	27	33	68	32	0	74	0	111	79	45	31	15
11	16	0	30	35	42	200	15	46	0	100	83	32	37	0	0	0
12	0	0	30	7	0	177	0	14	0	0	0	8	32	0	0	8
0+	18324	18056	11892	8397	12803	15549	10899	14719	9941	17026	12284	15470	11382	12903	18626	22097
1+	18324	18056	11892	8370	12607	15549	10899	14719	9914	17026	10088	15396	11294	12739	18626	22013
2+	17188	17652	11588	8232	12111	14255	10728	14336	9675	13536	9841	12725	10417	12570	17655	21416
3+	15378	9171	9703	5580	10938	11093	9358	11491	8386	9015	8784	9822	8256	11280	11130	10862
4+	12528	4458	6000	4175	5127	9230	6442	6389	6255	6756	5385	7084	6121	6309	6860	5792
5+	7451	3701	2717	1674	3781	5597	4043	3239	3154	4365	4020	3994	3883	3465	4001	3999
6+	5220	1967	1859	880	1524	3152	1822	2309	1341	2287	2759	2375	2043	1695	1658	2169
7+	2223	1181	1272	564	314	1769	888	833	693	1138	1043	1327	990	587	792	1219
8+	957	75	1121	375	125	881	410	402	197	595	491	750	702	137	185	570
9+	338	21	460	314	125	591	150	147	86	235	236	281	405	137	110	215
10+	130	21	188	97	69	410	83	93	0	174	83	-151	148	45	31	23
11+	16	0	60	42	42	377	15	61	0	100	83	40	69	0	0	8
12+	0	0	30	7	0	177	0	14	0	0	0	8	32	0	0	8

BEGINNING.OF YEAR RV POPULATION STRATA 70-95 17/ 4/86

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	20	17	12	117	503	13	20	15	311	16	2422	255	122	399	24
2	3104	872	897	402	1253	1331	697	702	1039	1920	847	2403	1064	1050	3201
3	2920	5604	1628	3925	1479	3037	2644	2462	1706	3921	1700	2489	3278	2347	5752
4	1469	3933	3043	1375	4595	2114	3031	3978	2257	1756	3241	2475	2464	3770	2767
5	2966	806	1614	2376	1814	2841	1494	2389	2539	1736	1487	2384	1990	2581	2287
6	1325	1008	521	980	1766	1511	1811	777	1443	1888	1149	1306	1428	1238	1492
7	1820	345	333	245	1037	813	634	856	594	796	995	549	688	820	750
8	263	855	96	14	234	480	350	218	423	372	509	414	17	184	464
9	25	122	379	58	13	139	119	149	82	234	182	347	165	9	120
10	65	11	122	76	43	111	46	7	80	8	130	101	108	53	34
11	11	25	67	48	73	23	56	6	10	79	6	64	9	7	6
12	4	5	15	6	86	14	15	7	1	10	26	32	6	1	3
1+	13994	13605	8727	9623	12897	12427	10915	11566	10485	12736	12694	12820	11339	12459	16900
2+	13974	13587	8715	9505	12394	12414	10896	11550	10173	12720	10272	12565	11217	12060	16876
3+	10869	12715	7817	9103	11141	11083	10199	10848	9134	10800	9425	10163	10153	11010	13675
4+	7949	7111	6190	5178	9663	8046	7555	8386	7428	6880	7725	7673	6875	8663	7923
5+	6479	3178	3146	3802	5068	5932	4524	4408	5171	5124	4483	5198	4411	4893	5156
6+	3513	2372	1532	1427	3253	3091	3030	2019	2632	3388	2997	2813	2421	2312	2869
7+	2188	1363	1012	447	1487	1580	1220	1242	1189	1499	1847	1508	993	1074	1377
8+	368	1018	678	202	450	767	586	386	596	703	853	958	305	254	627
9+	105	163	582	188	216	287	236	168	173	331	344	545	288	70	163
10+	80	42	204	130	202	148	117	20	91	96	162	197	123	61	43
11+	15	30	82	54	160	37	71	12	11	89	32	96	15	8	8
12+	4	5	15	6	86	14	15	7	1	10	26	32	6	1	3

(B) Beginning of year numbers calculated from the geometric mean of within-cohort values between adjacent years

Table 7. Weight (kg) and biomass ('000 t) at age as derived from summer RV surveys.

WEIGHT AT AGE STRATA 70-95 17/ 4/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.12	0.07	0.12	0.07	0.10	0.14	0.09	0.15	0.11	0.07	0.12	0.03	0.11	0.05	0.08	0.08
2	0.58	0.40	0.65	0.53	0.48	0.60	0.49	0.66	0.69	0.46	0.63	0.18	0.52	0.59	0.60	0.61
3	1.35	0.83	1.43	1.16	1.27	1.15	1.30	1.47	1.53	1.53	1.62	0.76	1.51	1.31	1.39	1.32
4	2.34	1.94	2.21	2.81	2.03	2.36	1.96	2.31	2.61	2.58	3.83	1.95	2.47	1.81	2.49	2.12
5	3.40	2.99	3.68	3.91	3.91	3.12	3.59	3.54	3.70	4.11	5.16	3.38	3.95	3.16	2.88	3.22
6	4.28	3.40	4.90	5.48	5.82	5.07	5.42	5.73	5.61	4.83	6.13	5.17	5.56	4.47	3.84	3.86
7	5.41	5.57	4.34	7.39	5.94	6.86	6.91	7.22	7.96	7.80	9.49	6.04	8.11	6.12	4.71	5.83
8	7.61	6.25	7.36	6.43	0.00	6.33	8.70	9.99	10.43	10.36	8.54	8.41	9.09	0.00	11.28	7.51
9	9.36	0.00	7.94	8.43	12.55	9.55	8.51	6.09	10.32	10.08	11.11	0.00	11.62	8.98	7.50	9.52
10	11.54	12.08	11.29	7.36	6.58	0.00	8.74	0.00	0.00	18.92	0.00	0.00	11.45	7.41	13.41	14.30
11	14.81	0.00	14.66	4.25	9.56	16.30	15.14	0.00	0.00	15.71	11.42	0.00	9.64	0.00	0.00	0.00
12	0.00	0.00	14.66	14.92	0.00	8.72	0.00	17.08	0.00	0.00	0.00	0.00	15.73	0.00	0.00	15.51

BIOMASS AT AGE STRATA 70-95 17/ 4/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	136	28	36	10	50	181	15	57	26	244	30	80	96	8	78	48
2	1050	3392	1226	1405	563	1897	671	1878	889	2080	665	522	1124	761	3915	6438
3	3848	3912	5295	1630	7380	2143	3791	7499	3260	3457	5508	2081	3224	6512	5935	6692
4	11880	1470	7255	7029	2733	8575	4701	7276	8095	6167	5228	6026	5528	5148	7119	3801
5	7588	5183	3159	3103	8822	7627	7975	3294	6707	8542	6507	5473	7268	5593	6748	5893
6	12825	2674	2875	1732	7045	7009	5060	8458	3638	5548	10519	5418	5855	4953	3325	3667
7	6850	6158	657	1400	1125	6094	3307	3107	3949	4239	5236	3482	2336	2754	2859	3784
8	4716	341	4864	391	0	1837	2257	2550	1149	3732	2180	3948	2700	0	846	2666
9	1946	0	2158	1831	698	1730	569	332	892	612	1693	0	2996	826	592	1828
10	1307	249	1453	402	176	0	594	0	0	1402	0	0	905	333	416	214
11	244	0	438	149	403	3255	234	0	0	1569	952	0	357	0	0	0
12	0	0	438	108	0	1544	0	246	0	0	0	0	503	0	0	124
0+	52388	23407	29852	19187	28995	41893	29174	34698	28606	37592	38516	27029	32881	26889	31833	35155
1+	52388	23407	29852	19187	28995	41893	29174	34698	28606	37592	38516	27029	32881	26889	31833	35155
2+	52251	23378	29815	19178	28946	41712	29159	34640	28579	37348	38487	26949	32784	26880	31756	35107
3+	51202	19986	28589	17772	28382	39815	28488	32762	27690	35268	37821	26426	31661	26119	27841	28669
4+	47354	16074	23295	16142	21003	37672	24697	25263	24430	31811	32313	24345	28437	19607	21905	21977
5+	35474	14604	16040	9114	18270	29097	19996	17987	16335	25645	27086	18319	22909	14460	14786	18176
6+	27887	9421	12881	6011	9447	21469	12021	14693	9628	17103	20579	12847	15641	8866	8039	12283
7+	15062	6747	10006	4279	2402	14460	6961	6235	5990	11555	10061	7429	9786	3914	4713	8616
8+	8212	590	9349	2879	1277	8366	3654	3129	2041	7315	4825	3948	7451	1160	1854	4832
9+	3497	249	4486	2489	1277	6529	1397	578	892	3583	2645	0	4751	1160	1008	2166
10+	1551	249	2328	658	580	4799	828	246	0	2971	952	0	1765	333	416	339
11+	244	0	875	256	403	4799	234	246	0	1569	952	0	860	0	0	124
12+	0	0	438	108	0	1544	0	246	0	0	0	0	503	0	0	124

Table 8. Input data used in the construction of the catch-at-age matrix. A) Quarterly catch data used in calculation of numbers-at-age (foreign landings are annual), B) Number of samples available for key construction, and C) Length-weight parameters (A/B).

(A)

	Otter Trawl				Longline and Handline				Gillnet				Miscellaneous				
Year	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	Foreign
1948	10	19	18	15	7005	3569	440	6685	0	0	0	0	0	0	0	0	1999
1949	21	40	38	31	5601	2854	352	5345	0	0	0	0	0	0	0	0	1799
1950	5	10	9	8	7543	3843	474	7197	0	0	0	0	0	0	0	0	1581
51	51	99	95	76	6421	3271	403	6127	0	0	0	0	0	0	0	0	1639
52	10	20	19	15	6533	3328	410	6234	0	0	0	0	0	0	0	0	1651
53	32	61	58	47	5029	2562	316	4798	0	0	0	0	0	0	0	0	1461
54	26	58	39	48	119	66	15	121	0	0	0	0	2032	5680	4342	1860	2542
55	21	43	72	52	139	18	0	114	0	0	0	0	2010	5112	4011	1840	1378
56	58	97	73	40	240	263	22	265	0	0	0	0	1717	4461	5067	2546	1663
57	41	143	199	173	922	545	132	548	0	0	0	0	670	4416	4563	1267	1083
58	45	205	269	203	674	456	146	553	0	0	0	0	355	2930	3334	1933	1110
59	142	470	599	186	554	671	162	403	0	0	0	0	353	3586	4312	1428	862
1960	50	371	594	228	699	2632	4313	1409	0	1	0	0	33	278	1085	430	1605
61	62	511	683	410	683	3092	3413	1841	12	25	234	249	12	257	845	95	1274
62	56	885	1217	904	474	2967	4468	1338	0	35	412	198	4	246	1250	202	1240
63	322	895	1319	1230	466	3785	4265	1159	0	59	455	234	11	298	1124	227	1995
64	1096	2247	2257	1171	242	812	433	346	0	0	0	0	288	3540	6224	2111	4688
65	1544	4826	3912	2111	430	1540	2206	755	0	90	382	293	14	1752	3536	830	2693
66	1737	4265	4895	1768	758	1623	777	1019	0	76	497	-278	9	1605	3805	1132	6735
67	1974	5256	5239	2354	513	3029	4571	1432	7	127	948	765	23	509	838	228	4648
68	2633	6527	5001	2677	689	3027	5388	1480	27	330	688	809	31	600	722	141	4773
69	3849	4000	2870	1340	705	3455	4224	812	35	218	323	350	54	464	1046	311	8670
1970	1177	2193	1184	1495	603	2565	4284	1442	13	145	150	344	130	831	1091	354	4308
71	972	1766	1519	1444	914	3766	5838	1639	20	201	228	96	59	752	688	278	3197
72	1245	2004	2412	901	678	3332	5546	1546	13	77	200	896	29	443	653	515	1902
73	981	1284	1631	480	1395	4551	5488	2366	10	73	203	392	43	471	484	150	2222
74	220	1066	1924	690	1296	4115	5214	1989	28	229	338	1349	30	207	178	132	2166
75	107	1035	3353	585	1053	4468	3885	1499	25	122	322	1041	23	1524	205	246	1595
76	408	1099	1531	669	842	2811	4214	1473	32	521	889	1136	13	191	253	56	517
77	642	2566	2275	1295	1625	4068	4267	1878	57	484	550	1040	53	472	466	264	949
78	1106	2394	3040	1155	2470	3335	4898	1648	188	549	629	1295	58	497	194	273	288
79	1096	2260	2097	2259	1848	4108	6710	1899	384	496	447	2317	293	641	1149	671	47
1980	1857	4455	2778	2179	2175	5532	5389	2722	368	677	625	1072	181	400	514	165	187
81	1601	2171	2890	1990	4430	5657	6114	2767	532	435	797	1220	42	177	162	105	130
82	763	3531	4121	2647	4240	5470	6017	2166	588	844	1038	796	46	114	137	192	235
83	1647	4640	5048	1654	2819	4898	4002	1377	214	510	1185	370	225	193	108	73	298
84	1501	2520	6715	1867	2744	3139	3165	1633	108	182	783	261	136	144	105	65	194
85	1434	2996	4532	2304	1510	2374	2807	1027	338	289	1027	294	128	163	109	39	9

Table 8. (Continued)

(B)

Year	Gear	Jan-Mar	Apr-June	July-Sept	Oct-Dec
1948	OT	0	1	0	0
	LL	2	10	3	4
1949	LL	4	4	5	5
1950	LL	1	7	5	2
51	LL	3	7	4	3
52	LL	3	4	5	2
53	LL	2	2	5	6
54	LL	3	6	2	2
55	LL	1	5	5	6
56	LL	2	1	1	2
57	LL	2	0	0	1
58	LL	0	6	0	0
59	LL	1	0	2	0
1960	LL	0	3	0	0
61	LL	1	1	0	2
62	OT	0	1	0	0
	LL	1	0	0	2
63	OT	0	0	0	2
	LL	1	1	0	1
64	LL	0	3	0	0
65	OT	0	4	3	1
66	OT	0	0	2	0
	LL	1	1	0	0
67	OT	1	6	3	2
68	OT	2	7	0	1
69	OT	0	2	4	3
1970	OT	0	0	1	1
71	OT	0	1	3	1
	LL	2	0	2	1
72	OT	4	1	5	3
	LL	0	0	1	1
73	OT	1	1	1	1
	LL	0	2	0	2
74	LL	1	2	2	2
75	OT	0	2	2	1
	LL	1	3	1	1
	GN	0	0	0	2
76	OT	1	1	3	0
	LL	0	0	0	2
	GN	0	0	1	0
77	OT	2	0	4	1
	LL	3	1	3	1

Table 8. (Continued)

Year	Gear	Jan-Mar	Apr-June	July-Sept	Oct-Dec
1978	OT	5	0	3	0
	LL	8	1	0	0
	GN	0	0	1	0
79	OT	1	2	0	4
	LL	2	3	0	0
1980	OT	5	3	2	5
	LL	12	7	3	8
	GN	1	0	2	0
81	OT	8	5	3	1
	LL	11	17	4	5
	GN	0	1	2	2
82	OT	3	10	3	2
	LL	6	7	6	3
	GN	0	0	1	3
83	OT	3	5	8	3
	LL	4	6	4	0
	GN	0	0	1	0
84	OT	5	3	8	2
	LL	7	12	7	1
	GN	0	0	2	0
85	OT	8	7	4	4
	LL	5	7	5	0

(C)

Year	Jan-Mar	Apr-June	July-Sept	Oct-Dec
1948-69	.0081/3.0503	.0084/3.041	.0088/3.0315	.0063/3.1152
1970	-	-	.0076/3.0696	.0063/3.1152
71	.0081/3.0503	.0084/3.041	.0111/2.9632	.0063/3.1152
72	.0081/3.0503	.0084/3.041	.0125/2.9451	.0063/3.1152
73	.0081/3.0503	.0084/3.041	.0083/3.0345	.0063/3.1152
74	.0081/3.0503	.0084/3.041	.009/3.0165	.0063/3.1152
75	.0081/3.0503	.0084/3.041	.0065/3.1054	.0063/3.1152
76	.0081/3.0503	.0084/3.041	.0074/3.0632	.0063/3.1152
77	.0081/3.0503	.0084/3.041	.0074/3.0718	.0063/3.1152
78	.0081/3.0503	.0084/3.041	.0093/3.0233	-
79	.0064/3.0988	.0075/3.0627	.0088/3.0269	.0042/3.2079
1980	.0091/3.0249	.008/3.0582	.0068/3.0914	.0069/3.0912
81	.0081/3.0503	.0084/3.041	.008/3.0556	.0086/3.0339
82	.0087/3.0272	.0102/2.9921	.0117/2.9571	.0063/3.1071
83	.009/3.0157	.0093/3.0094	.0097/3.0031	.0057/3.1356
84	.0058/3.1198	.0084/3.041	.0077/3.0636	.0065/3.1007
85	.0074/3.0491	.0084/3.041	.0069/3.0812	.0063/3.1152

Table 9. Catch numbers-at-age by gear category.

(A) OT

OT NUMBERS AT AGE (THOUSANDS) 30/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	3	1	7	2	2	3	1	1	0	9	0	0	1	0	0	0	15	7	9	6	174
3	0	11	3	48	5	13	5	17	10	8	47	32	0	31	321	25	29	729	999	755	758	978
4	0	12	4	33	10	10	21	9	41	14	71	199	25	52	1065	196	201	1275	2272	2931	1290	785
5	2	8	2	23	4	19	9	16	16	55	34	173	87	255	1094	495	833	1414	1529	1804	2942	855
6	0	7	1	9	2	7	11	7	11	9	48	111	73	114	19	302	684	1024	623	599	1186	740
7	1	0	1	7	1	3	4	7	10	23	5	43	25	40	3	93	229	316	262	207	215	209
8	1	1	0	5	1	1	1	2	9	11	10	42	30	13	3	74	206	72	129	158	90	71
9	1	1	0	1	1	2	1	1	2	13	9	9	18	11	0	26	103	27	13	63	117	51
10	2	1	0	0	0	3	1	0	1	11	6	0	10	5	0	2	21	14	20	17	27	90
11	0	0	0	2	0	1	1	1	2	0	1	2	5	2	0	2	7	7	3	17	18	9
12	0	0	0	1	0	0	0	0	2	4	1	2	1	1	0	0	22	1	1	4	14	2
13	0	0	0	0	0	0	0	0	1	5	0	0	3	0	0	0	2	0	0	1	2	3
14	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	2
15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	2	4	6

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	2	0	0	0	0	0	3	38	0
2	84	331	153	85	17	494	191	1075	245	111	135	646	548	678	762	716
3	396	631	1167	260	362	712	716	1113	1092	276	1725	1702	1146	2893	1968	1253
4	418	327	1331	556	391	681	506	481	900	883	623	1309	1432	1382	1619	884
5	468	515	380	500	385	297	318	241	727	570	793	344	1050	887	812	1147
6	287	378	105	124	257	103	122	147	333	288	456	141	249	429	270	464
7	132	89	59	109	65	72	34	52	132	103	125	55	75	123	134	199
8	23	99	28	11	52	11	10	87	65	38	102	27	33	25	47	59
9	66	23	23	4	37	7	7	27	8	17	31	12	20	20	10	16
10	16	9	8	7	23	1	2	7	22	22	17	3	7	10	7	6
11	5	6	0	7	23	4	1	0	0	3	8	5	4	3	1	6
12	7	7	2	0	12	0	1	11	6	2	8	1	3	2	0	3
13	0	3	1	0	2	0	1	0	4	3	4	1	2	0	1	1
14	0	0	0	1	2	0	1	1	1	0	1	1	0	0	0	0
15	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	5	0	0	0	0	2	1	0	0	0	2	0

Table 9. (Continued)

(B) LL

LL NUMBERS AT AGE (THOUSANDS)

24/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	36	442	611	253	707	105	7	2	5	0	29	0	0	7	2	0	0	6	0	4	2
3	806	1314	1811	2334	1138	747	11	26	31	31	137	38	0	170	245	271	7	207	0	443	550
4	1617	1251	3074	1697	2652	641	37	12	110	53	205	241	181	260	350	1334	47	356	194	1807	686
5	1568	813	1323	1323	1089	1244	17	22	27	211	88	209	637	1246	872	624	195	444	297	951	1798
6	676	799	710	444	510	395	18	9	23	34	118	141	530	587	952	487	160	379	354	355	788
7	247	60	668	427	324	197	8	11	17	88	11	55	180	212	414	652	53	143	387	136	140
8	341	93	36	247	154	62	2	4	18	42	23	57	221	62	193	149	48	96	70	137	57
9	340	130	46	75	235	155	2	1	5	50	21	11	129	51	67	148	24	23	13	44	72
10	202	143	84	24	27	197	3	0	2	42	13	0	71	27	45	29	5	11	17	10	19
11	87	46	11	96	19	67	2	1	4	0	3	3	33	13	5	31	2	8	14	18	13
12	50	14	63	64	12	15	1	0	4	14	1	2	9	6	0	26	5	3	14	4	10
13	43	27	5	15	27	0	1	0	3	20	1	0	20	0	10	14	0	5	3	1	2
14	66	8	0	14	5	24	0	0	0	9	0	0	0	0	3	5	0	1	0	0	2
15	2	21	29	6	0	0	0	0	0	0	1	0	0	0	3	4	0	0	0	0	1
16	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	3

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	115	116	5	104	174	56	95	180	235	16	169	711	199	401	62	18	118
3	656	522	223	708	1292	1320	520	823	1379	332	816	2712	2088	1339	868	334	236
4	524	929	422	1012	1398	1175	1722	1812	879	983	1934	1043	2600	2793	653	1482	452
5	612	665	408	1197	1055	1042	478	868	1097	991	1379	1288	1082	1782	857	822	993
6	573	157	375	684	436	651	385	176	493	1622	483	606	775	417	653	548	531
7	184	166	267	72	116	144	193	47	175	399	328	228	378	261	311	257	229
8	57	31	198	71	51	109	54	61	123	92	137	96	227	164	203	94	89
9	40	95	110	96	136	47	38	17	56	40	43	38	121	94	99	42	39
10	58	21	126	49	52	64	30	14	58	24	45	32	50	70	53	42	29
11	8	7	19	3	36	55	16	6	29	8	17	4	20	19	41	24	16
12	3	1	52	0	13	19	7	0	21	9	9	8	17	19	6	22	4
13	2	0	71	0	7	6	8	2	8	2	0	0	19	16	17	5	5
14	1	0	0	3	7	9	0	0	20	1	5	0	5	0	5	2	1
15	4	0	38	0	14	8	0	2	2	1	0	1	2	4	0	3	1
16	8	0	6	16	0	7	0	0	10	1	4	2	6	0	2	13	3

Table 9. (Continued)

(C) GN

GN NUMBERS AT AGE (THOUSANDS) 24/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	12	8
3	0	0	0	0	0	0	0	0	0	0	0	0	0	19	21	44	0	24	0	86	96	66	38
4	0	0	0	0	0	0	0	0	0	0	0	0	0	23	30	145	0	42	41	350	120	53	67
5	0	0	0	0	0	0	0	0	0	0	0	0	0	74	64	57	0	66	64	184	315	62	48
6	0	0	0	0	0	0	0	0	0	0	0	0	0	35	66	35	0	71	70	69	138	58	11
7	0	0	0	0	0	0	0	0	0	0	0	0	0	8	27	41	0	26	78	30	25	19	12
8	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12	11	0	29	14	26	10	6	2
9	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	11	0	6	3	9	13	4	7
10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2	0	3	4	2	3	6	2
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	3	4	2	1	1
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	3	1	2	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	1	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	26	15	16	1	0	60	4	12	0	14	0	0	0	42
3	10	69	74	255	0	0	241	267	72	84	177	3	0	11	77
4	20	128	70	252	71	10	163	261	254	194	428	154	0	55	123
5	20	84	44	128	45	128	148	158	428	279	227	429	563	163	268
6	18	61	21	90	89	138	73	127	328	168	85	189	30	83	139
7	12	6	4	15	48	98	25	74	206	56	93	56	171	42	51
8	9	6	3	15	6	46	21	31	23	37	40	99	17	15	21
9	5	7	7	8	2	48	9	4	29	15	31	24	13	1	9
10	5	4	1	6	0	0	9	0	5	0	11	21	6	0	8
11	1	1	1	4	0	0	5	0	2	0	2	29	6	5	3
12	2	0	0	2	5	0	4	0	1	0	0	5	0	0	1
13	3	0	0	0	0	0	1	0	0	0	0	0	0	0	1
14	0	1	0	1	0	0	2	0	1	0	0	0	0	0	0
15	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
16	0	1	0	1	1	0	1	0	0	0	0	0	0	0	1

Table 9. (Continued)

(D) Miscellaneous

MISCELLANEOUS NUMBERS AT AGE (THOUSANDS) 24/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	208	47	90	0	109	0	0	1	0	0	0	7	4	1	1	31
3	0	0	0	0	0	0	391	1114	521	157	575	235	0	21	74	42	51	378	379	81	71	153
4	0	0	0	0	0	0	1656	578	1988	271	871	1424	37	34	182	194	363	626	987	314	113	120
5	0	0	0	0	0	0	744	1081	592	1070	410	1238	128	171	260	138	1500	673	671	186	259	132
6	0	0	0	0	0	0	865	456	484	174	565	772	107	79	138	98	1233	498	375	61	105	110
7	0	0	0	0	0	0	294	510	416	447	59	293	36	29	60	91	412	147	243	22	19	32
8	0	0	0	0	0	0	114	166	386	214	118	284	45	9	28	28	371	58	76	17	8	10
9	0	0	0	0	0	0	108	51	94	253	105	61	26	7	10	25	186	16	9	7	10	7
10	0	0	0	0	0	0	111	30	31	214	66	0	14	4	6	4	38	9	14	2	2	11
11	0	0	0	0	0	0	76	54	63	0	17	18	7	2	1	5	13	5	6	2	2	1
12	0	0	0	0	0	0	28	28	61	70	7	12	2	1	0	4	40	2	6	0	1	1
13	0	0	0	0	0	0	26	14	37	101	5	0	4	0	1	2	4	2	1	0	0	0
14	0	0	0	0	0	0	19	3	7	47	0	0	0	0	0	1	0	0	0	0	0	0
15	0	0	0	0	0	0	11	0	0	0	5	0	0	0	0	1	0	0	0	0	0	1
16	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	5	0	1	0	0	1

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2	34	30	30	14	3	22	13	89	11	33	41	15	21	10	12	11
3	175	84	165	99	55	99	54	175	71	129	214	68	37	69	38	27
4	314	78	214	126	52	267	77	92	96	328	81	69	67	45	61	29
5	214	93	132	98	46	109	44	85	87	251	99	27	48	46	34	49
6	48	80	72	33	30	69	14	41	94	116	50	15	12	26	18	25
7	50	34	10	11	7	29	6	14	26	66	16	8	5	13	9	12
8	10	27	8	4	5	14	4	13	9	20	9	5	4	6	3	5
9	28	14	10	9	3	9	2	6	2	9	3	2	2	3	1	2
10	6	13	5	4	3	3	1	5	2	7	2	1	1	2	1	1
11	2	2	0	3	3	5	0	2	0	2	0	0	1	1	1	1
12	0	6	0	1	1	2	0	2	1	1	1	0	0	0	0	0
13	0	7	0	0	0	0	0	1	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
15	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0
16	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0

Table 9. (Continued)

(E) Foreign

FOREIGN NUMBERS AT AGE (THOUSANDS)

24/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	44	47	35	54	13	41	5	9	0	13	0	0	1	0	0	0	3	4	3	2	125	77
3	0	150	134	244	122	99	74	122	60	16	72	20	0	24	130	13	20	158	531	237	215	703	400
4	0	168	196	167	265	73	311	63	256	27	109	123	32	40	431	104	139	277	1208	919	366	564	718
5	69	109	116	119	96	144	138	117	97	106	53	106	113	195	443	262	576	307	813	566	834	615	490
6	0	102	62	47	44	48	157	49	67	17	74	66	94	87	8	160	474	222	331	188	336	532	111
7	23	7	63	34	36	22	53	54	63	44	8	26	32	31	3	49	158	69	139	65	61	150	114
8	23	11	4	25	15	10	21	18	57	21	16	26	39	10	1	39	143	16	69	50	26	51	22
9	23	19	5	6	18	18	18	5	14	25	14	5	23	8	0	14	71	6	7	20	33	37	63
10	61	18	7	2	3	19	20	3	6	21	9	0	13	4	0	1	14	3	11	5	8	65	14
11	15	5	2	9	2	5	13	5	10	0	2	1	6	2	0	1	5	2	1	5	5	6	5
12	0	2	4	5	1	1	5	3	11	7	1	1	2	1	0	0	15	0	0	1	4	2	1
13	8	3	1	1	1	0	4	1	6	10	1	0	3	0	0	0	1	0	0	0	1	2	0
14	8	1	0	1	1	3	3	0	1	5	0	0	0	0	0	0	0	0	0	0	1	1	0
15	23	2	1	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	1	4	0

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2	186	44	43	10	155	27	150	9	1	2	10	12	16	12	1
3	354	338	132	201	224	100	156	41	2	29	26	24	66	30	1
4	183	386	282	217	214	71	67	34	5	10	20	30	32	25	1
5	289	110	254	214	93	44	34	27	3	13	5	22	20	13	1
6	212	31	63	143	32	17	21	12	2	8	2	5	10	4	0
7	50	17	55	36	23	5	7	5	1	2	1	2	3	2	0
8	55	8	6	29	3	1	12	2	0	2	0	1	1	1	0
9	13	7	2	21	2	1	4	0	0	1	0	0	0	0	0
10	5	2	4	13	0	0	1	1	0	0	0	0	0	0	0
11	4	0	4	13	1	0	0	0	0	0	0	0	0	0	0
12	4	0	0	5	0	0	2	0	0	0	0	0	0	0	0
13	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0

Table 10. Numbers and percent numbers-at-age.

TOTAL NUMBERS AT AGE (THOUSANDS) 30/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
1	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
2	36	489	660	295	763	120	260	54	105	0	160	0	0	11	2	0	0	32	15
3	806	1475	1947	2626	1265	860	482	1279	622	211	831	326	0	265	792	376	106	1498	1909
4	1617	1431	3274	1898	2927	724	2024	662	2395	365	1257	1986	275	409	2057	1972	751	2576	4703
5	1639	930	1441	1465	1189	1407	909	1236	731	1442	585	1726	966	1940	2734	1576	3104	2903	3372
6	676	908	773	500	557	450	1051	521	584	234	805	1093	804	901	1183	1083	2550	2194	1753
7	270	67	732	468	361	222	358	583	505	602	84	417	273	320	513	927	852	701	1108
8	364	105	40	277	170	74	139	190	470	288	168	409	336	97	237	301	768	271	357
9	363	150	51	82	254	175	129	58	116	341	149	87	196	79	81	222	385	78	44
10	265	162	91	26	30	219	136	34	40	288	94	0	107	41	55	39	78	41	65
11	103	52	13	107	21	73	91	60	78	0	23	25	51	18	6	41	27	23	26
12	50	16	67	71	13	16	35	32	78	94	10	16	13	9	0	33	83	7	24
13	51	30	6	16	28	0	31	16	47	136	7	0	30	0	12	17	8	9	5
14	74	9	1	16	6	27	23	4	9	64	0	0	0	0	3	7	0	1	0
15	26	23	31	7	0	0	13	0	0	0	7	0	0	0	3	4	0	0	0
16	0	0	1	0	0	0	2	4	0	0	0	0	0	0	0	0	10	0	3

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	4	39	0
2	17	11	456	272	553	358	331	101	766	410	1609	285	326	889	884	982	766	804	808
3	1601	1690	2557	1341	1302	2446	1857	2193	1556	1693	3063	1303	1294	4763	4060	2549	3896	2381	1594
4	6321	2575	2047	1398	1031	3071	2432	2088	2955	2476	1683	2274	3405	1951	4426	4476	2112	3243	1488
5	3690	6149	2277	1565	1324	1903	1952	1814	1022	1401	1606	1991	2632	2472	1684	3332	2376	1845	2458
6	1271	2554	2014	980	1062	953	676	1171	679	467	775	2188	1217	1287	1018	873	1148	923	1159
7	480	459	595	435	452	165	295	267	365	190	272	636	703	427	535	398	620	444	491
8	388	191	195	78	388	122	75	209	88	122	257	199	218	245	299	301	251	159	174
9	142	246	140	215	165	141	159	116	58	74	101	55	99	87	166	140	136	54	66
10	36	59	229	52	159	67	68	109	35	18	81	49	79	52	65	99	71	50	44
11	46	40	25	17	32	4	52	98	26	7	36	9	23	12	27	52	52	31	26
12	11	31	8	26	72	2	15	39	14	2	39	16	13	16	18	27	9	22	8
13	2	6	8	0	87	1	7	9	8	4	10	6	3	4	20	18	18	6	8
14	1	6	5	0	0	4	8	13	0	1	25	2	7	1	6	0	5	2	2
15	0	3	10	0	43	0	15	20	0	2	2	1	0	1	2	4	0	4	1
16	5	10	20	0	7	18	0	17	1	0	12	1	7	3	6	0	2	15	4

Table 10. (Continued)

PERCENT NUMBERS AT AGE 30/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.08	0.07	0.04	0.10	0.03	0.05	0.01	0.02	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
3	0.13	0.25	0.21	0.33	0.17	0.20	0.08	0.27	0.11	0.05	0.20	0.05	0.00	0.06	0.10	0.06	0.01	0.14	0.14	0.11	0.12	0.24	0.21
4	0.25	0.24	0.36	0.24	0.39	0.17	0.36	0.14	0.41	0.09	0.30	0.33	0.09	0.10	0.27	0.30	0.09	0.25	0.35	0.45	0.18	0.19	0.22
5	0.26	0.16	0.16	0.19	0.16	0.32	0.16	0.26	0.13	0.35	0.14	0.28	0.32	0.47	0.36	0.24	0.36	0.23	0.25	0.26	0.44	0.22	0.25
6	0.11	0.16	0.08	0.06	0.07	0.10	0.18	0.11	0.10	0.06	0.19	0.18	0.26	0.22	0.15	0.16	0.29	0.21	0.13	0.09	0.18	0.19	0.15
7	0.04	0.01	0.08	0.06	0.05	0.05	0.06	0.12	0.09	0.15	0.02	0.07	0.09	0.08	0.07	0.14	0.10	0.07	0.08	0.03	0.03	0.06	0.07
8	0.06	0.02	0.00	0.04	0.02	0.02	0.02	0.04	0.08	0.07	0.04	0.07	0.11	0.02	0.03	0.05	0.09	0.03	0.03	0.03	0.01	0.02	0.01
9	0.06	0.03	0.01	0.01	0.03	0.04	0.02	0.01	0.02	0.08	0.04	0.01	0.06	0.02	0.01	0.03	0.04	0.01	0.00	0.01	0.02	0.01	0.03
10	0.04	0.03	0.01	0.00	0.00	0.05	0.02	0.01	0.01	0.07	0.02	0.00	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.01
11	0.02	0.01	0.00	0.01	0.00	0.02	0.02	0.01	0.01	0.00	0.01	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
13	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.08	0.04	0.04	0.01	0.10	0.06	0.17	0.03	0.03	0.07	0.07	0.07	0.07	0.08	0.11
3	0.19	0.26	0.23	0.27	0.21	0.25	0.32	0.19	0.13	0.39	0.31	0.19	0.34	0.24	0.19
4	0.15	0.33	0.31	0.25	0.39	0.36	0.18	0.24	0.34	0.16	0.33	0.34	0.18	0.32	0.18
5	0.20	0.21	0.25	0.22	0.13	0.20	0.17	0.21	0.26	0.20	0.13	0.25	0.21	0.18	0.29
6	0.16	0.10	0.09	0.14	0.09	0.07	0.08	0.23	0.12	0.11	0.08	0.07	0.10	0.09	0.14
7	0.07	0.02	0.04	0.03	0.05	0.03	0.03	0.07	0.07	0.04	0.04	0.03	0.05	0.04	0.06
8	0.06	0.01	0.01	0.03	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
9	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
10	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.01
11	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 11. Catch weight and percent catch weight-at-age.

CATCH BIOMASS (T)

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
1	0	0	0	0	0	0	0	4	0	0	0	0	2	0	0	[illegible]
2	22	562	543	209	661	119	246	42	66	0	185	0	0	3	1	[illegible]
3	370	1884	2166	2981	1898	1218	618	1368	783	133	928	170	0	228	604	274
4	2078	3154	3849	3001	5207	1741	3373	1092	4583	130	1747	2875	338	946	2334	2480
5	3320	2662	3798	3674	2838	4799	2461	3782	1901	3301	1544	2976	2202	5141	4283	3369
6	1909	3211	2461	1914	1809	1739	4452	2304	2546	685	3347	2388	2814	3729	3548	3186
7	1185	290	2503	2332	1961	1283	1689	3209	2875	1948	477	1902	1614	1930	3484	4396
8	2042	647	386	1767	945	503	889	1025	2620	1426	899	2207	2088	573	1710	1288
9	2330	1107	308	489	1170	741	748	413	765	2250	1170	736	1487	765	344	1888
10	1760	1225	796	212	155	1220	979	305	219	1667	839	0	1270	473	438	319
11	896	431	138	727	126	499	682	334	630	0	236	275	798	242	80	169
12	529	161	664	495	200	105	205	300	542	380	56	79	90	145	0	318
13	534	350	33	177	329	0	277	156	355	934	88	0	500	0	147	170
14	1091	73	13	207	99	123	260	35	64	571	0	0	0	0	54	90
15	350	251	308	76	0	0	164	0	0	0	76	0	0	0	58	49
16	0	0	23	0	0	0	24	63	0	0	3	0	0	0	0	0

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2	0	21	7	9	9	352	176	336	248	240	60	525	246	1678	240
3	90	1337	1998	1634	1599	3215	1898	1128	3420	2342	2383	1911	2020	3873	2834
4	976	4237	7465	10165	3792	3744	3084	1748	6211	5336	3233	6329	5310	3122	4332
5	6201	6783	8152	8833	13705	7362	4677	3616	4665	6055	4746	3222	4207	3764	4764
6	8161	7719	5783	4263	8652	8123	4778	4109	3942	2448	5130	4161	2066	3316	7783
7	3264	3455	4463	2521	2497	3276	2680	2794	816	1446	1474	2417	1153	1566	2653
8	4590	1557	1930	2511	1306	1735	540	2733	830	588	1374	798	1041	1989	1215
9	3492	892	305	1085	1953	1296	1107	1501	867	1519	996	545	804	219	349
10	734	433	508	343	572	1844	415	1613	424	768	969	469	212	760	455
11	345	334	213	427	445	375	221	433	72	537	1102	344	111	392	98
12	950	63	267	138	412	113	452	913	32	155	605	190	21	607	115
13	122	114	43	39	84	127	0	1242	21	126	143	104	55	139	40
14	0	19	0	9	98	84	0	0	79	140	153	0	34	418	26
15	0	0	0	0	53	160	0	683	0	282	338	0	30	37	15
16	176	0	54	89	169	367	0	114	282	0	282	20	0	186	22

	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	1	15	0
2	271	632	666	800	649	766	732
3	1647	6725	5058	3393	5181	3568	2242
4	6931	4230	8786	8276	3912	6498	2934
5	8192	7352	4722	9472	6210	5037	6184
6	5046	6108	3666	3603	4832	3528	4091
7	3755	2865	3018	2173	3463	2403	2435
8	1584	1694	2167	2131	2021	1211	1199
9	856	836	1387	1170	1397	508	531
10	691	509	726	895	811	585	432
11	248	146	334	555	599	406	318
12	160	227	223	381	129	316	122
13	50	48	303	251	284	91	94
14	89	7	88	5	86	28	18
15	0	11	36	60	0	59	18
16	120	44	104	0	39	259	56

Table 11. (Continued).

PERCENT CATCH WEIGHT AT AGE

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.04	0.03	0.01	0.04	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.05	0.12	0.11	0.17	0.10	0.09	0.04	0.09	0.04	0.01	0.08	0.01	0.00	0.02	0.04	0.01	0.00	0.05	0.06
4	0.12	0.20	0.28	0.17	0.30	0.12	0.20	0.09	0.25	0.03	0.15	0.17	0.03	0.05	0.14	0.13	0.03	0.16	0.24
5	0.17	0.16	0.20	0.21	0.17	0.34	0.15	0.26	0.11	0.24	0.13	0.23	0.16	0.37	0.26	0.18	0.22	0.26	0.26
6	0.10	0.20	0.13	0.11	0.10	0.12	0.27	0.16	0.14	0.05	0.29	0.18	0.21	0.27	0.21	0.18	0.28	0.28	0.19
7	0.06	0.02	0.13	0.13	0.11	0.09	0.10	0.22	0.16	0.13	0.04	0.15	0.12	0.13	0.16	0.23	0.11	0.13	0.14
8	0.11	0.04	0.02	0.08	0.05	0.04	0.05	0.07	0.15	0.10	0.09	0.17	0.15	0.04	0.10	0.11	0.16	0.06	0.06
9	0.12	0.07	0.02	0.03	0.07	0.05	0.04	0.03	0.04	0.16	0.10	0.06	0.13	0.05	0.04	0.08	0.12	0.03	0.01
10	0.09	0.08	0.04	0.01	0.01	0.09	0.04	0.02	0.01	0.12	0.07	0.00	0.09	0.03	0.03	0.02	0.03	0.02	0.02
11	0.05	0.03	0.01	0.04	0.01	0.04	0.04	0.02	0.04	0.00	0.02	0.02	0.06	0.02	0.00	0.03	0.01	0.01	0.01
12	0.03	0.01	0.03	0.03	0.01	0.01	0.01	0.02	0.03	0.04	0.00	0.01	0.01	0.01	0.00	0.02	0.03	0.00	0.01
13	0.03	0.02	0.00	0.01	0.02	0.00	0.02	0.01	0.02	0.07	0.01	0.00	0.04	0.00	0.01	0.01	0.00	0.00	0.00
14	0.06	0.00	0.00	0.01	0.01	0.01	0.02	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.02	0.02	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.01	0.07	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
3	0.05	0.04	0.10	0.09	0.05	0.16	0.11	0.10	0.09	0.12	0.17	0.11	0.06	0.21	0.16	0.10	0.17	0.14	0.10
4	0.32	0.11	0.12	0.15	0.08	0.28	0.24	0.14	0.30	0.31	0.14	0.17	0.23	0.13	0.28	0.23	0.13	0.26	0.14
5	0.28	0.37	0.23	0.23	0.16	0.21	0.28	0.21	0.15	0.24	0.17	0.19	0.27	0.23	0.15	0.29	0.21	0.20	0.29
6	0.13	0.24	0.25	0.24	0.18	0.18	0.11	0.22	0.20	0.12	0.15	0.31	0.17	0.19	0.12	0.11	0.16	0.14	0.19
7	0.08	0.07	0.10	0.13	0.12	0.04	0.07	0.06	0.11	0.07	0.07	0.11	0.13	0.09	0.10	0.07	0.12	0.10	0.11
8	0.08	0.04	0.05	0.03	0.12	0.04	0.03	0.06	0.04	0.06	0.09	0.05	0.05	0.05	0.07	0.06	0.07	0.05	0.06
9	0.03	0.05	0.04	0.06	0.07	0.04	0.07	0.04	0.03	0.05	0.04	0.01	0.03	0.03	0.04	0.04	0.05	0.02	0.02
10	0.01	0.02	0.06	0.02	0.07	0.02	0.04	0.04	0.02	0.01	0.03	0.02	0.03	0.02	0.02	0.03	0.03	0.02	0.02
11	0.01	0.01	0.01	0.01	0.02	0.00	0.02	0.05	0.02	0.01	0.02	0.00	0.01	0.00	0.01	0.02	0.02	0.02	0.01
12	0.00	0.01	0.00	0.02	0.04	0.00	0.01	0.03	0.01	0.00	0.03	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01
13	0.00	0.00	0.00	0.00	0.05	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00

Table 12. Comparison of original (1984) and revised catch-at-age matrices for the period 1977-84. Matrix was revised as a result of changes in gear aggregations during construction of age-length keys.

ORIGINAL CATCH AT AGE MATRIX 1/ 5/86

	1977	1978	1979	1980	1981	1982	1983	1984
1	2	11	1	1	1	1	3	37
2	1439	393	496	943	885	1000	793	786
3	3046	2321	1644	4902	4102	2610	4084	2369
4	1724	2391	3617	1907	4500	4578	2223	3259
5	1651	1906	2500	2410	1688	3304	2229	1785
6	777	1711	892	1227	1043	825	1149	893
7	279	547	515	408	525	399	556	426
8	279	168	189	245	288	270	243	155
9	105	51	71	81	164	136	128	55
10	83	20	72	57	65	99	67	51
11	36	6	18	12	29	41	48	30
12	43	5	15	18	17	25	9	23
13	10	1	1	4	19	18	18	6

REVISED CATCH AT AGE MATRIX 1/ 5/86

	1977	1978	1979	1980	1981	1982	1983	1984
1	2	1	1	1	1	1	4	39
2	1609	285	326	889	884	982	766	804
3	3063	1803	1294	4763	4060	2549	3896	2381
4	1683	2274	3405	1951	4426	4476	2112	3243
5	1606	1991	2632	2472	1684	3332	2376	1845
6	775	2188	1217	1287	1018	873	1148	923
7	272	636	703	427	535	398	620	444
8	257	199	218	245	299	301	251	159
9	101	55	99	87	166	140	136	54
10	81	49	79	52	65	99	71	50
11	36	9	23	12	27	52	52	31
12	39	16	13	16	18	27	9	22
13	10	6	3	4	20	18	18	6

RATIO OF REVISED AND ORIGINAL CATCH AT AGE MATRICES

	1977	1978	1979	1980	1981	1982	1983	1984
1	0.98	0.09	1.00	1.00	1.00	1.00	1.07	1.04
2	1.12	0.73	0.66	0.94	1.00	0.98	0.97	1.02
3	1.01	0.78	0.79	0.97	0.99	0.98	0.95	1.01
4	0.98	0.95	0.94	1.02	0.98	0.98	0.95	0.99
5	0.97	1.04	1.05	1.03	1.00	1.01	1.07	1.03
6	1.00	1.28	1.36	1.05	0.98	1.06	1.00	1.03
7	0.97	1.16	1.36	1.05	1.02	1.00	1.11	1.04
8	0.92	1.18	1.15	1.00	1.04	1.11	1.03	1.02
9	0.97	1.08	1.39	1.08	1.01	1.02	1.06	0.99
10	0.97	2.44	1.11	0.92	1.00	1.00	1.05	0.99
11	1.01	1.37	1.31	1.06	0.95	1.27	1.09	1.03
12	0.91	2.94	0.91	0.90	1.04	1.09	0.92	0.95
13	1.05	5.45	2.71	0.98	1.02	0.98	0.96	1.01

Table 13.

MEAN WEIGHT (KG) IN CATCH 30/ 4/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
1	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.00
2	0.62	1.15	0.82	0.71	0.87	0.99	0.95	0.78	0.63	0.00	0.66	0.00	0.00	0.32
3	1.08	1.28	1.11	1.14	1.34	1.42	1.28	1.07	1.23	0.63	1.11	0.52	0.00	0.86
4	1.41	2.20	1.63	1.58	1.81	2.40	1.67	1.95	1.91	1.18	1.39	1.15	1.23	1.58
5	2.03	2.82	2.64	2.51	2.49	3.41	2.71	3.02	2.60	2.29	2.64	1.72	2.28	2.65
6	2.82	3.54	3.18	3.82	3.25	3.86	4.24	4.43	4.36	2.93	4.16	2.19	3.50	4.14
7	4.38	4.34	3.42	4.98	5.44	5.64	4.72	5.51	5.69	3.07	5.69	4.56	5.92	5.71
8	5.61	6.17	8.26	4.94	5.57	6.83	6.41	5.39	5.58	4.96	5.96	5.39	6.22	5.91
9	6.41	7.39	6.07	6.00	4.61	4.23	5.78	7.13	6.57	6.60	7.35	8.45	9.03	9.49
10	6.65	7.55	8.72	8.09	5.15	5.58	5.01	8.85	5.55	5.79	8.92	0.00	11.85	11.49
11	8.71	8.29	10.57	6.82	5.89	6.81	7.50	5.52	8.10	0.00	10.10	11.13	15.77	13.27
12	10.54	11.58	9.95	7.00	15.64	6.47	5.91	9.46	6.93	6.15	5.53	4.98	6.88	16.78
13	10.50	11.50	5.43	11.17	11.74	0.00	8.92	9.76	7.62	6.86	12.57	0.00	16.78	0.00
14	14.72	8.46	16.80	13.05	16.78	4.57	11.42	9.15	6.91	8.99	0.00	0.00	0.00	0.00
15	13.49	10.81	9.99	11.67	0.00	0.00	12.44	0.00	0.00	0.00	11.21	0.00	0.00	0.00
16	0.00	0.00	15.52	0.00	0.00	0.00	15.52	15.52	0.00	0.00	15.52	0.00	0.00	0.00

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.28	0.00	0.00	0.64	0.50	0.53	0.78	0.77	0.65	0.61	0.69	0.73	0.60
3	0.76	0.69	0.85	0.89	1.05	1.02	0.95	1.26	1.41	0.87	1.40	1.26	1.09
4	1.14	1.26	1.30	1.64	1.59	1.61	1.55	1.83	2.21	1.70	2.02	2.19	1.55
5	1.57	2.13	2.03	2.41	2.42	2.39	2.23	3.23	2.99	2.73	2.45	3.10	2.62
6	3.00	3.01	3.20	3.52	3.30	3.35	3.39	4.03	4.88	3.87	4.13	3.62	4.38
7	5.23	4.63	3.83	4.93	4.03	5.26	5.44	5.50	6.17	6.19	4.96	4.90	5.53
8	7.23	6.50	5.98	5.74	5.40	6.47	6.85	8.90	6.95	7.05	6.83	7.63	6.56
9	7.55	7.10	9.08	11.31	6.95	7.64	7.95	9.26	5.14	9.11	6.14	9.54	8.62
10	7.99	7.94	9.45	10.63	7.82	9.48	9.75	8.05	8.04	10.18	6.36	11.28	8.90
11	7.66	11.41	12.75	14.47	8.09	9.27	11.12	14.88	12.84	13.44	16.55	10.42	11.27
12	0.00	9.71	11.47	9.28	11.35	13.08	13.22	13.70	17.38	12.77	15.01	10.55	15.41
13	12.32	10.02	15.52	0.00	8.43	17.38	14.74	16.35	0.00	14.33	17.49	16.78	15.31
14	16.92	13.66	0.00	0.00	0.00	16.78	15.72	16.78	0.00	0.00	17.93	16.80	11.82
15	16.92	11.17	0.00	0.00	0.00	0.00	16.92	15.24	0.00	15.72	0.00	16.78	17.01
16	0.00	0.00	16.78	0.00	16.78	16.92	17.50	17.93	0.00	16.55	15.81	0.00	15.41

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.36	0.38	0.37
2	0.69	0.60	1.04	0.84	0.83	0.71	0.75	0.81	0.85	0.95	0.82
3	1.23	1.19	1.26	1.57	1.27	1.41	1.25	1.33	1.33	1.50	1.41
4	2.14	2.14	1.86	1.91	2.04	2.17	1.99	1.85	1.85	2.00	1.97
5	3.15	3.00	2.34	2.39	3.11	2.97	2.80	2.84	2.61	2.73	2.52
6	6.13	4.42	4.28	3.54	4.15	4.75	3.60	4.13	4.21	3.82	3.53
7	6.63	6.07	5.76	4.17	5.34	6.70	5.64	5.46	5.58	5.42	4.76
8	8.97	8.56	7.75	6.16	7.26	6.91	7.24	7.08	8.05	7.61	6.89
9	9.41	10.83	9.08	6.18	8.65	9.56	8.37	8.38	10.26	9.34	8.09
10	13.52	12.01	9.44	9.22	11.24	9.80	11.21	9.07	11.42	11.69	9.86
11	13.30	16.17	10.75	6.56	10.64	11.85	12.27	10.63	11.59	13.27	12.41
12	13.54	12.47	15.41	7.23	12.00	14.02	12.41	14.16	15.10	14.15	14.52
13	12.66	14.90	15.83	6.90	16.72	11.59	15.35	13.99	16.13	14.34	12.31
14	0.00	16.32	16.65	13.33	13.56	9.32	15.34	16.14	16.14	15.10	12.28
15	0.00	17.93	15.54	16.92	0.00	17.52	14.51	16.54	0.00	16.74	16.20
16	14.01	0.00	16.01	16.92	16.57	17.37	16.69	0.00	15.98	17.01	14.62

Table 14. Results of the Survivor analysis. The calibration block was 1972-84, ages 2-7. K was set at age 6.

INTEGRATED CATCH 86/04/28

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	9226	13289	15379	12499	16490	16005	11358	22461	19854	12691	14614	5538	2373	467
3	8638	6516	9695	11908	9098	11867	11553	8560	15983	13941	8797	9689	3972	838
4	6417	4860	3542	5587	7819	5919	7315	7062	5523	8929	7536	5100	4712	782
5	2226	3004	2069	1513	2635	4572	3174	3758	3140	2880	3620	3112	2387	1232
6	863	682	1062	589	578	1185	2011	1163	1331	1023	1218	1146	1086	610
7	87	155	140	192	100	143	334	370	225	281	209	326	233	253

INTEGRATED SURVIVORS 86/04/28

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	3528	4864	1215	4892	4713	2150	2802	4527	3450	5651	8799	9136	34594	103877
3	4153	2888	3982	995	4003	3860	1760	2294	3707	2825	4791	7204	7460	28323
4	1968	3405	2365	3260	814	3279	3160	1441	1878	3035	2313	3922	5898	6124
5	573	1611	2787	1936	2669	667	2685	2568	1180	1538	2485	1893	3211	4829
6	593	469	1319	2282	1585	2185	546	2178	2118	966	1259	2034	1550	2629
7	388	486	384	1080	1866	1298	1789	447	1800	1734	791	1031	1666	1269

POPULATION NUMBERS 86/04/28

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	12754	18153	16594	17391	21205	18154	14160	26988	23304	18543	23413	14674	36767	104344
3	12794	9405	13677	12802	13103	15727	13313	10855	19690	16765	13588	16893	10552	29161
4	8386	8265	5907	8847	8634	9198	10476	8503	7401	11964	9849	9022	10610	6906
5	2799	4615	4856	3451	5304	5239	5859	6346	4320	4418	6304	5006	5600	6121
6	1456	1151	2381	2872	2164	3371	2556	3361	3450	1988	2477	3181	2636	3239
7	474	641	524	1272	1968	1441	2124	817	2024	2016	1000	1357	1899	1527

ESTIMATED SURVIVORS 86/04/28

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	3136	4305	0	6248	0	4038	462	7405	0	6511	3355	4378	46043	94012
3	3761	110	7471	0	2029	5195	0	957	180	0	753	8689	13006	21404
4	2681	2058	648	3721	404	2691	1911	765	0	1089	258	3116	4133	5132
5	330	0	3161	3865	2749	0	1622	1787	563	1422	1284	1576	3831	4173
6	725	230	2027	2777	1742	2553	18	1809	3002	1678	1546	1726	1208	2146
7	351	397	411	2349	1269	1092	1106	1209	1363	1382	628	983	1512	1609

ESTIMATED VARIANCE OF SURVIVORS 86/04/2

8

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	7534797	14897464	2917631	21186687	3977194	17151287	3519081	43305723	2363281	26634015	22021273
3	10342116	1489340	25471611	2618699	6415369	19633201	3425068	3851213	8720586	5655771	5130016
4	6732622	3909199	1132637	8249443	3594074	6198949	6009986	3569436	1164025	5966183	3129479
5	551859	471634	3812215	4475313	3694870	648383	2460452	3234215	1190607	1963151	2535179
6	363752	105519	1548352	2019329	921021	2302255	444361	1394368	3111189	1160248	1171625
7	34803	54527	54527	1199500	348245	281405	374173	449000	462709	505074	126078

	1983	1984	1985
2	11706582	446816813	1681613480
3	41488554	45668244	92618556
4	7539262	11366212	6430897
5	2345954	6132468	5381662
6	1297213	792442	1371837
7	307808	560058	640243

WEIGHTED SURVIVORS 86/04/28

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	64	80	0	81	0	23	22	53	0	194	444	1423	7905	94012
3	91	11	81	0	87	86	0	41	6	0	117	610	1084	17729
4	106	132	87	125	16	119	103	21	0	56	20	329	1059	3036
5	20	0	208	132	206	0	181	179	46	120	156	161	497	2259
6	94	73	349	345	289	308	6	356	313	141	219	409	366	1244
7	351	345	254	522	915	593	820	383	807	689	465	531	829	603

Table 14. (Continued)

ESTIMATED SURVIVORS FOR AGE 7 (WEIGHTED)

YEAR	SURVIVORS	VARIANCE	STANDARD ERROR	C.V.(S/S)
1972	351	34803	187	53.11
1973	440	47419	218	49.50
1974	348	33751	184	52.82
1975	978	286784	517	52.82
1976	1392	251157	501	29.62
1977	1175	152675	391	33.25
1978	1620	277380	527	32.50
1979	405	142395	377	93.16
1980	1630	274035	523	32.12
1981	1571	324751	570	36.25
1982	716	97430	312	43.58
1983	934	166262	408	43.68
1984	1508	307103	554	36.74
1985	1149	239832	490	42.61

ESTIMATED SURVIVORS FOR 1985 (WEIGHTED)

AGE	SURVIVORS	VARIANCE	STANDARD ERROR	C.V.(S/S)
2	94012	1681613480	41007	43.62
3	25634	76716379	8759	34.17
4	5543	3804909	1951	35.19
5	4371	2912820	1707	39.04
6	2381	795461	892	37.46
7	1149	239832	490	42.61

FINAL ESTIMATION FOR K

AGE	K	LN(K)	VAR(LN(K)	STANDARD ERROR	D.F
2	9.89	2.1894	0.2040	0.1253	1
3	4.83	1.5001	0.1499	0.1074	1
4	3.60	1.2563	0.0490	0.0614	1
5	3.23	1.1015	0.1397	0.1037	1
6	3.14	1.0133	0.2604	0.1001	25
7	3.14	1.0133	0.2604	0.1001	25

RESIDUALS 86/04/28

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	0.3799	0.3677	-0.3577	0.5867	-0.4480	0.4381	-0.1053	0.5047	-0.8026	0.4370	-0.0913	-0.1400	0.5570	0.0002
3	0.3351	-0.3261	0.7191	-0.3523	0.0725	0.4492	-0.2572	0.0056	-0.1813	-0.2370	-0.2757	0.3518	0.6704	-0.1745
4	0.3429	0.0857	-0.1979	0.3909	-0.0001	0.2091	0.0636	0.0117	-0.4097	-0.0729	-0.2010	0.1263	-0.0305	-0.0677
5	-0.0106	-0.5891	0.4049	0.8265	0.3009	-0.5567	-0.0018	0.0551	-0.0600	0.1675	-0.0601	0.1317	0.3000	-0.0361
6	0.2347	-0.1488	0.4670	0.4125	0.3031	0.3178	-0.2282	0.0700	0.4452	0.5030	0.2882	0.0890	0.0303	-0.0830
7	0.0007	-0.0756	0.1255	0.7846	-0.2705	-0.0651	-0.3105	0.7364	-0.1565	-0.1084	-0.1015	0.0398	0.0031	0.2877

MEAN OF RESIDUALS=0.0823978008
STANDARD DEVIATION OF RESIDUALS=0.3296442155

OUTLIERS OF RESIDUALS 86/04/28

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.80	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	-0.59	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

```
      NEWTON
NAME OF CATCH MATRIX ?...
DCAGE
NATURAL MORTALITY ?...
0:
      .2
STARTING YEAR AND AGE ?...
0:
      1972 2
         2  115806  0.0085
         3   33067  0.0546
         4    8406  0.2164
         5    6033  0.4084
         6    4180  0.3627
         7    1943  0.3249
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1972	610	0.3512
1973	861	0.4711
1974	717	0.5229
1975	1595	0.2890
1976	2276	0.0965
1977	1735	0.1893
1978	2677	0.3021
1979	1259	0.9338
1980	2461	0.2120
1981	2506	0.2672
1982	1311	0.4048
1983	1819	0.4671
1984	2330	0.2347
1985	1943	0.3249

$F_T = 0.38$

Table 15. Population matrix derived from cohort analysis with F_t = 0.40.

POPULATION NUMBERS

86/05/0

3

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
1	17952	24847	12697	16157	8828	18516	9119	14152	16519	18223	16076	23970	29094
2	13511	14697	20342	10394	13227	7227	15159	7465	11582	13524	14918	13161	19624
3	9198	11029	11590	16058	8243	10139	5608	12176	6063	9388	11072	12070	10774
4	9528	6801	7695	7727	10771	5604	7524	4319	8812	4401	7495	8313	9587
5	7368	6338	4274	3338	4609	6170	3933	4328	2938	5048	3273	4999	5009
6	1795	4549	4348	2196	1408	2698	3778	2398	2425	1744	2828	2150	2531
7	1096	858	2903	2860	1345	649	1801	2143	1492	1457	1216	1587	771
8	1016	653	642	1714	1918	775	330	1151	1227	764	648	920	923
9	1053	502	439	489	1153	1417	567	145	770	580	366	379	382
10	614	534	275	314	327	714	1002	347	66	525	166	164	231
11	180	263	290	143	233	240	387	697	253	18	170	51	134
12	241	54	168	226	21	172	130	234	516	137	14	118	19
13	142	152	30	78	121	5	126	75	163	352	27	2	82
1+	63692	71276	65694	61693	52203	54326	49664	49631	52827	56160	58268	67884	79162
2+	45741	46429	52997	45536	43376	35810	40545	35479	36308	37937	42192	43914	50068
3+	32230	31733	32655	35142	30148	28583	25387	28014	24725	24413	27274	30753	30444
4+	23032	20703	21065	19084	21905	18444	19578	15838	18662	15025	16202	18683	19669

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	18826	22692	33667	42777	20772	16370	16168	14272	20705	19669	15369	20734	24381
2	23820	15412	18578	27563	35022	17006	13402	13236	11684	16951	16103	12582	16975
3	16066	19492	12617	15209	22566	28644	13910	10958	10827	9153	13633	12684	9977
4	8820	12914	15242	9972	12356	17120	21725	9940	7442	6551	6280	9984	8171
5	7600	6851	8712	10695	7484	7785	9762	12067	5808	4241	4099	4209	5396
6	3227	4467	3136	5707	5948	3501	3322	4653	4316	2695	2056	2158	1724
7	1345	1827	2587	1588	2365	2884	1280	1570	1499	1711	1320	722	904
8	385	811	1032	1279	529	1302	1359	614	870	689	1008	672	442
9	452	227	450	572	353	187	743	761	330	536	494	474	440
10	136	298	113	167	120	218	114	480	401	144	244	255	260
11	92	74	194	57	67	62	120	60	340	121	71	56	148
12	64	59	55	122	22	34	27	57	13	255	83	29	42
13	4	44	48	15	25	12	6	12	18	3	185	3	22
1+	80836	85169	96429	115723	107629	95127	81937	68679	64253	62720	60945	64563	68883
2+	62010	62477	62763	72946	86857	78756	65770	54408	43548	43051	45576	43829	44503
3+	38190	47065	44185	45383	51835	61750	52367	41172	31864	26100	29473	31247	27527
4+	22124	27573	31568	30174	29269	33106	38458	30214	21037	16946	15841	18563	17550

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	20418	25545	24904	17284	32825	30945	24665	32465	17157	16037	30284	678
2	19960	16716	20914	20388	14149	26874	25335	20193	26579	14046	13127	24759
3	13599	16251	12993	16751	15237	11327	21708	19938	15733	20873	10807	10020
4	6489	9150	11897	9106	10943	10843	8102	13464	12651	10575	13564	6694
5	4489	3423	4817	7500	5932	6902	5797	4868	7018	6307	6747	8171
6	2652	2034	1878	2676	4688	3055	3270	2510	2462	2731	3014	3855
7	800	1111	1051	1115	1490	1858	1401	1512	1134	1226	1197	1632
8	473	413	580	688	667	644	885	760	754	568	442	579
9	295	198	259	365	332	366	330	503	352	345	238	218
10	216	137	110	145	207	222	210	191	262	161	159	146
11	152	79	81	74	46	125	110	125	98	125	68	85
12	75	36	41	60	27	30	81	79	78	33	56	28
13	21	26	17	32	13	8	12	52	48	39	19	25
1+	69639	75118	79541	76185	86556	93200	91907	96659	84325	73066	79721	56890
2+	49221	49573	54637	58900	53731	62255	67241	64195	67168	57029	49438	56212
3+	29260	32857	33723	38512	39582	35380	41906	44001	40589	42983	36311	31453
4+	15661	16607	20730	21761	24345	24054	20198	24063	24856	22110	25504	21433

Table 16. Fishing mortality matrix derived from cohort analysis with $F_t = 0.40$.

FISHING MORTALITY AND WEIGHTED F FOR FULLY-RECRUITED AGES 86/05/0

3

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.003	0.037	0.036	0.032	0.066	0.018	0.019	0.008	0.010	0.000	0.012	0.000	0.000	0.001
3	0.102	0.160	0.205	0.199	0.186	0.098	0.096	0.123	0.120	0.025	0.087	0.030	0.000	0.018
4	0.208	0.265	0.635	0.317	0.357	0.154	0.353	0.186	0.357	0.096	0.205	0.307	0.032	0.053
5	0.282	0.177	0.466	0.664	0.336	0.290	0.295	0.379	0.322	0.379	0.220	0.481	0.240	0.331
6	0.538	0.249	0.219	0.290	0.574	0.204	0.367	0.274	0.310	0.160	0.378	0.825	0.432	0.369
7	0.318	0.090	0.327	0.199	0.352	0.476	0.248	0.358	0.469	0.610	0.079	0.343	0.495	0.305
8	0.505	0.196	0.072	0.197	0.103	0.111	0.623	0.201	0.550	0.538	0.337	0.677	0.515	0.328
9	0.480	0.400	0.137	0.204	0.279	0.147	0.291	0.584	0.183	1.052	0.600	0.293	0.834	0.216
10	0.647	0.410	0.456	0.097	0.107	0.413	0.162	0.116	1.079	0.931	0.986	0.007	0.718	0.407
11	1.002	0.246	0.051	1.742	0.107	0.411	0.301	0.101	0.414	0.062	0.166	0.774	0.543	0.246
12	0.262	0.385	0.576	0.425	1.163	0.110	0.349	0.162	0.183	1.427	1.542	0.162	1.403	0.162
13	0.496	0.249	0.247	0.254	0.294	0.235	0.316	0.265	0.376	0.550	0.336	0.580	0.508	0.336
6+	0.496	0.249	0.247	0.254	0.294	0.235	0.316	0.265	0.376	0.550	0.336	0.580	0.508	0.336

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.044	0.018	0.039	0.032	0.022	0.006	0.052
3	0.046	0.035	0.008	0.076	0.077	0.136	0.187	0.302	0.177	0.112	0.240	0.230	0.196	0.112
4	0.194	0.154	0.087	0.262	0.362	0.388	0.337	0.362	0.269	0.200	0.415	0.399	0.439	0.442
5	0.582	0.223	0.387	0.560	0.652	0.541	0.828	0.568	0.524	0.442	0.693	0.510	0.592	0.460
6	0.346	0.481	0.681	0.524	0.806	0.549	0.933	0.725	0.514	0.846	0.670	0.568	0.669	0.460
7	0.371	0.504	0.899	0.397	0.553	0.535	0.390	0.578	0.329	0.475	0.290	0.448	0.460	0.450
8	0.389	0.390	1.088	0.837	0.361	0.380	0.420	0.285	0.133	0.554	0.223	0.206	0.672	0.268
9	0.501	0.788	1.359	0.280	0.300	0.237	0.442	0.632	0.587	0.460	0.399	0.510	0.568	0.391
10	0.227	0.484	0.718	0.468	0.398	0.433	0.145	1.000	0.506	1.267	0.341	0.341	0.811	0.329
11	0.102	0.266	0.746	0.480	0.640	0.551	1.321	0.086	0.172	0.698	0.089	0.484	1.247	0.452
12	0.019	1.081	1.392	0.412	1.463	0.574	0.937	1.184	0.120	2.996	0.086	0.487	0.867	0.570
13	0.352	0.493	0.823	0.499	0.625	0.479	0.702	0.630	0.403	0.713	0.478	0.475	0.656	0.431
6+	0.352	0.493	0.823	0.499	0.625	0.479	0.702	0.630	0.403	0.713	0.478	0.475	0.656	0.431

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
2	0.022	0.091	0.022	0.013	0.040	0.050	0.042	0.062	0.070	0.040
3	0.156	0.226	0.140	0.135	0.278	0.255	0.197	0.231	0.279	0.192
4	0.261	0.228	0.261	0.426	0.309	0.451	0.496	0.249	0.307	0.280
5	0.388	0.270	0.464	0.547	0.637	0.482	0.744	0.539	0.360	0.400
6	0.321	0.386	0.725	0.580	0.571	0.595	0.497	0.625	0.413	0.400
7	0.223	0.314	0.638	0.541	0.411	0.496	0.491	0.819	0.527	0.400
8	0.264	0.531	0.400	0.469	0.366	0.571	0.582	0.670	0.507	0.400
9	0.381	0.366	0.202	0.355	0.346	0.453	0.578	0.572	0.291	0.400
10	0.196	0.952	0.305	0.303	0.319	0.470	0.538	0.665	0.427	0.400
11	0.099	0.792	0.239	0.230	0.132	0.275	0.890	0.609	0.689	0.400
12	0.046	1.304	1.034	0.692	0.249	0.291	0.482	0.339	0.586	0.400
13	0.280	0.421	0.642	0.535	0.475	0.537	0.523	0.671	0.448	0.400
6+	0.280	0.421	0.642	0.535	0.475	0.537	0.523	0.671	0.448	0.400

Table 17. Mid-year estimate of SPA population biomass (x 10^{-3}).

MID-YEAR POPULATION BIOMASS

6/ 5/94

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
1	7742	10716	5476	7309	3807	7986	3933	9958	7125	7959	6933	10338	12548
2	7614	14999	14891	6550	10034	6430	12867	5248	6569	9738	9847	5934	11956
3	8537	11770	10525	14929	9125	12377	6422	11075	6332	5285	10496	5594	10127
4	10935	11886	8282	9440	14740	11286	9508	6956	12710	4479	8512	7393	10490
5	11730	14826	8075	5437	8769	15466	8316	9780	5886	8652	6888	6133	9167
6	3503	12854	11227	6571	3107	8511	12053	8370	8192	4256	8815	2814	6458
7	3706	3219	7621	11669	5548	2508	6790	8927	6076	2993	6011	5523	3226
8	4002	3302	4628	6943	9189	4526	1402	5078	4705	2622	2951	3197	4014
9	4805	2748	2252	2399	4186	5043	2567	698	4182	2046	1923	2501	2059
10	2672	2971	1731	2189	1444	2931	4188	2625	194	1728	917	1750	1732
11	858	1746	2704	369	1178	1206	2259	3310	1509	90	1427	346	1454
12	2016	467	1137	1156	162	950	586	1849	2954	374	33	489	59
13	1055	1396	131	690	1108	57	867	583	933	1659	259	22	945

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	8119	9787	14520	18450	8959	7060	6973	6155	8930	8483	6629	9943	10515
2	6895	3905	11150	17075	20413	7690	6423	9337	7996	9953	8700	7759	11050
3	12370	13153	7708	11652	17544	24109	11999	8548	10591	10726	10115	14236	10149
4	12278	12137	16058	11231	16130	20521	26038	11781	10276	11433	8719	14846	13286
5	15443	7271	15037	16191	12314	12294	16142	16085	12796	8827	8123	6601	11774
6	10049	10198	6726	11755	14570	6984	7661	8947	10961	9199	4713	5775	4253
7	5968	7192	8429	3510	8654	7971	4660	6359	5592	9100	5827	2903	3202
8	1746	4366	4995	4018	1806	5314	6573	3084	6075	4054	4971	3716	2755
9	3479	1208	1949	2382	3140	1014	4558	4387	2019	1958	3232	2159	2946
10	1154	1922	636	1000	916	1267	785	3934	1769	912	1192	1236	2241
11	981	488	1756	452	689	328	755	314	4381	1297	608	905	1099
12	890	618	280	630	151	167	237	424	90	3782	215	376	315
13	35	414	337	142	224	67	80	115	196	31	1484	42	240

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	8806	11018	10741	7506	14158	13347	10638	14002	7400	5223	10405	227
2	10756	10107	11206	18380	10679	20123	15970	13436	19194	10435	10931	19105
3	12125	17078	12974	17121	20204	12190	24139	19787	17166	22377	12747	11594
4	7297	14219	20240	13637	16636	16139	13614	19297	16516	15644	21094	10387
5	7904	7995	10777	13897	10195	14786	11345	9705	12444	11394	13927	15230
6	7521	8962	6402	9546	10459	8581	10552	6077	7170	7510	9480	10075
7	3177	5324	5162	4966	4087	6851	6914	6025	4379	4112	4510	5997
8	2007	2934	3939	3704	3044	3347	4608	3744	3612	2940	2265	2952
9	1730	1386	2099	2497	1675	2401	2400	3039	1994	2408	1739	1308
10	1162	1419	1079	769	1484	1753	1590	1532	1643	1197	1362	1064
11	829	756	1122	482	241	1073	1102	1211	603	969	579	783
12	677	329	453	434	107	227	911	765	783	379	532	301
13	211	238	194	372	60	92	100	551	470	411	199	231

Table 18. Partial recruitment matrix derived from cohort analysis with $F_t = 0.40$.

PARTIAL RECRUITMENT 3/ 5/86

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.15	0.15	0.13	0.22	0.08	0.06	0.03	0.03	0.00	0.04	0.00	0.00	0.00	0.00	0.00
3	0.21	0.64	0.83	0.78	0.63	0.42	0.30	0.46	0.32	0.05	0.26	0.05	0.00	0.05	0.13	0.07
4	0.42	1.06	2.57	1.25	1.21	0.66	1.12	0.70	0.95	0.17	0.61	0.53	0.06	0.16	0.55	0.31
5	0.57	0.71	1.88	2.61	1.14	1.24	0.93	1.43	0.86	0.69	0.66	0.83	0.47	0.99	1.65	0.45
6	1.09	1.00	0.88	1.14	1.95	0.87	1.16	1.03	0.82	0.29	1.12	1.42	0.85	1.10	0.98	0.97
7	0.64	0.36	1.32	0.78	1.20	2.02	0.78	1.35	1.25	1.11	0.24	0.59	0.98	0.91	1.06	1.02
8	1.02	0.79	0.29	0.77	0.35	0.47	1.97	0.76	1.46	0.98	1.00	1.17	1.01	0.98	1.11	0.79
9	0.97	1.61	0.55	0.80	0.95	0.62	0.92	2.20	0.49	1.91	1.79	0.51	1.64	0.64	1.42	1.60
10	1.30	1.65	1.84	0.38	0.36	1.76	0.51	0.44	2.87	1.89	2.94	0.01	1.41	1.21	0.65	0.98
11	2.02	0.99	0.21	6.85	0.36	1.75	0.95	0.38	1.10	0.11	0.49	1.34	1.07	0.73	0.29	0.54
12	0.53	1.55	2.33	1.67	3.95	0.47	1.10	0.61	0.49	2.59	4.59	0.28	2.76	0.48	0.05	2.19
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.07	0.04	0.05	0.07	0.05	0.01	0.12	0.08	0.22	0.04	0.03
3	0.01	0.15	0.12	0.28	0.27	0.48	0.44	0.16	0.50	0.48	0.30	0.26	0.55	0.54	0.22	0.25
4	0.11	0.52	0.58	0.81	0.48	0.57	0.67	0.28	0.87	0.84	0.67	1.03	0.93	0.54	0.41	0.80
5	0.47	1.12	1.04	1.13	1.18	0.90	1.30	0.62	1.45	1.08	0.90	0.93	1.38	0.64	0.72	1.02
6	0.83	1.05	1.29	1.15	1.33	1.15	1.27	1.19	1.40	1.20	1.02	1.07	1.15	0.92	1.13	1.08
7	1.09	0.79	0.88	1.12	0.56	0.92	0.82	0.67	0.61	0.94	0.70	1.05	0.80	0.75	0.99	1.01
8	1.32	1.68	0.58	0.79	0.60	0.45	0.33	0.78	0.47	0.43	1.02	0.62	0.94	1.26	0.62	0.88
9	1.65	0.56	0.48	0.50	0.63	1.00	1.46	0.65	0.83	1.07	0.87	0.91	1.36	0.87	0.31	0.66
10	0.87	0.94	0.64	0.91	0.21	1.59	1.26	1.78	0.71	0.72	1.24	0.76	0.70	2.26	0.48	0.94
11	0.91	0.96	1.02	1.15	1.88	0.14	0.43	0.98	0.19	1.02	1.90	1.05	0.35	1.88	0.37	0.43
12	1.69	0.83	2.34	1.20	1.33	1.88	0.30	4.20	0.18	1.03	1.32	1.32	0.16	3.10	1.61	1.29
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.08	0.09	0.08	0.09	0.16	0.10
3	0.59	0.47	0.38	0.34	0.62	0.48
4	0.65	0.84	0.95	0.37	0.69	0.70
5	1.34	0.90	1.42	0.80	0.80	1.00
6	1.20	1.11	0.95	0.93	0.92	1.00
7	0.87	0.92	0.94	1.22	1.18	1.00
8	0.77	1.06	1.11	1.00	1.13	1.00
9	0.73	0.84	1.10	0.85	0.65	1.00
10	0.67	0.87	1.03	0.99	0.95	1.00
11	0.28	0.51	1.70	0.91	1.54	1.00
12	0.52	0.54	0.92	0.50	1.31	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00

Table 19. Yield-per-recruit analysis for 4X cod.

a) 1935 parameters

86/05/21 10.08

AGE	WEIGHT	PR	M
1	0.370	0.001	0.20
2	0.825	0.101	0.20
3	1.407	0.481	0.20
4	1.972	0.700	0.20
5	2.516	1.000	0.20
6	3.528	1.000	0.20
7	4.959	1.000	0.20
8	6.885	1.000	0.20
9	8.093	1.000	0.20
10	9.865	1.000	0.20
11	12.412	1.000	0.20
12	14.522	1.000	0.20
13	12.307	1.000	0.20
14	12.282	1.000	0.20
15	16.205	1.000	0.20
16	14.620	1.000	0.20

F0.1	FMAX	YIELD(F0.1)	YIELD(FMAX)
0.16	0.28	1.05	1.12

b) mean of 1981-85 weights and PR

86/05/21 10.10

AGE	WEIGHT	PR	M
1	0.413	0.001	0.20
2	0.839	0.101	0.20
3	1.362	0.481	0.20
4	1.932	0.700	0.20
5	2.701	1.000	0.20
6	3.858	1.000	0.20
7	5.412	1.000	0.20
8	7.375	1.000	0.20
9	8.891	1.000	0.20
10	10.651	1.000	0.20
11	12.035	1.000	0.20
12	14.069	1.000	0.20
13	14.424	1.000	0.20
14	15.000	1.000	0.20
15	16.114	1.000	0.20
16	16.212	1.000	0.20

F0.1	FMAX	YIELD(F0.1)	YIELD(FMAX)
0.16	0.27	1.11	1.18

c) mean of 1948-85 weights and PR

86/05/21 10.11

AGE	WEIGHT	PR	M
1	0.477	0.000	0.20
2	0.724	0.060	0.20
3	1.141	0.345	0.20
4	1.753	0.701	0.20
5	2.594	1.000	0.20
6	3.807	1.000	0.20
7	5.194	1.000	0.20
8	6.678	1.000	0.20
9	7.873	1.000	0.20
10	9.088	1.000	0.20
11	10.727	1.000	0.20
12	11.405	1.000	0.20
13	12.791	1.000	0.20
14	13.841	1.000	0.20
15	14.924	1.000	0.20
16	16.143	1.000	0.20

F0.1	FMAX	YIELD(F0.1)	YIELD(FMAX)
0.17	0.29	1.03	1.10

Table 20. Coefficients of variation (% CV)[1] for RV and commercial catch-at-age matrices in 1985. CV's are based on arithmetic means for the RV data and are thus overestimates. CV's for the commercial catch-at-age data are minimum estimates.

	Age															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
RV - mean catch per tow	29.6	38.7	33.7	29.2	22.7	17.7	19.3	29.7	42.9	72.1	/	/	/	/	139.0	/
Commercial catch at age	/	7.4	6.8	7.3	5.3	6.9	9.4	10.3	18.2	19.9	18.3	31.6	34.3	103.0	0.0	41.0

1 = calculated as S.E./mean

Table 21. Input to catch projection.

Age	Population No. ('000)	Weight at age (kg)**	Partial Recruitment ***
1	20052*	0.37	0.0008
2	24759	0.82	0.10
3	10020	1.41	0.48
4	6694	1.97	0.70
5	8171	2.52	1.00
6	3855	3.53	1.00
7	1632	4.96	1.00
8	579	6.88	1.00
9	218	8.09	1.00
10	146	9.86	1.00
11	85	12.41	1.00
12	28	14.52	1.00
13	25	12.31	1.00

* = GM age 1 recruitment between 1948-84.

** = 1985 values

*** = Mean of 1980-84 values for ages 1-4.

Table 22. Catch projection for 4X cod assuming a 1987 catch at $F_{0.1}$.

POPULATION NUMBERS 86/05/12

	1985	1986	1987
1	20150	20058	20060
2	33396	33096	32948
3	21759	19947	18413
4	13020	12406	10774
5	6354	6768	6486
6	3677	4137	4232
7	3856	4484	4389
8	1382	2116	2551
9	679	896	1220
10	219	319	517
11	146	120	183
12	85	80	69
13	38	47	46
14	25	15	27
1+	79264	74925	74283
2+	59244	54873	54231
3+	31433	38456	37818
4+	21433	18986	24843

CATCH NUMBERS 86/05/12

	1985	1986	1987
1	0	2	1
2	806	517	297
3	1601	2344	1301
4	1428	1337	1097
5	1368	1112	715
6	1139	1190	874
7	491	579	426
8	174	241	201
9	66	96	95
10	44	32	30
11	26	22	11
12	7	13	9
13	3	4	4
1+	8403	7896	4852
2+	8403	7892	4850
3+	7515	7375	4552
4+	5921	4631	3472

POPULATION BIOMASS (AVERAGE)

	1985	1986	1987
1	6724.37	6723.53	6723.90
2	18148.42	12062.60	12147.82
3	11558.09	22907.29	15795.68
4	10486.81	10774.45	22521.74
5	15459.33	8016.40	8993.42
6	10226.51	12166.51	6947.61
7	6087.39	8067.77	10569.95
8	2996.56	4744.06	6923.93
9	1327.94	1976.81	3446.46
10	1079.65	908.57	1489.46
11	794.98	762.46	706.60
12	306.07	522.05	551.39
13	234.91	145.11	273.45
1+	85530.03	89777.61	97091.43
2+	76805.66	83054.08	90367.52
3+	60657.24	70991.48	78219.71
4+	48999.15	48084.19	62424.02

CATCH BIOMASS 86/05/12

	1985	1986	1987
1	0	2	1
2	732	426	245
3	2242	3859	1519
4	2934	2641	3151
5	6184	2809	1799
6	4091	4263	1390
7	2435	2827	2114
8	1199	1662	1385
9	531	693	689
10	432	318	298
11	313	267	141
12	122	183	110
13	94	51	55
1+	21314	20000	12897
2+	21314	19998	12895
3+	20582	19572	12650
4+	18339	15713	11131

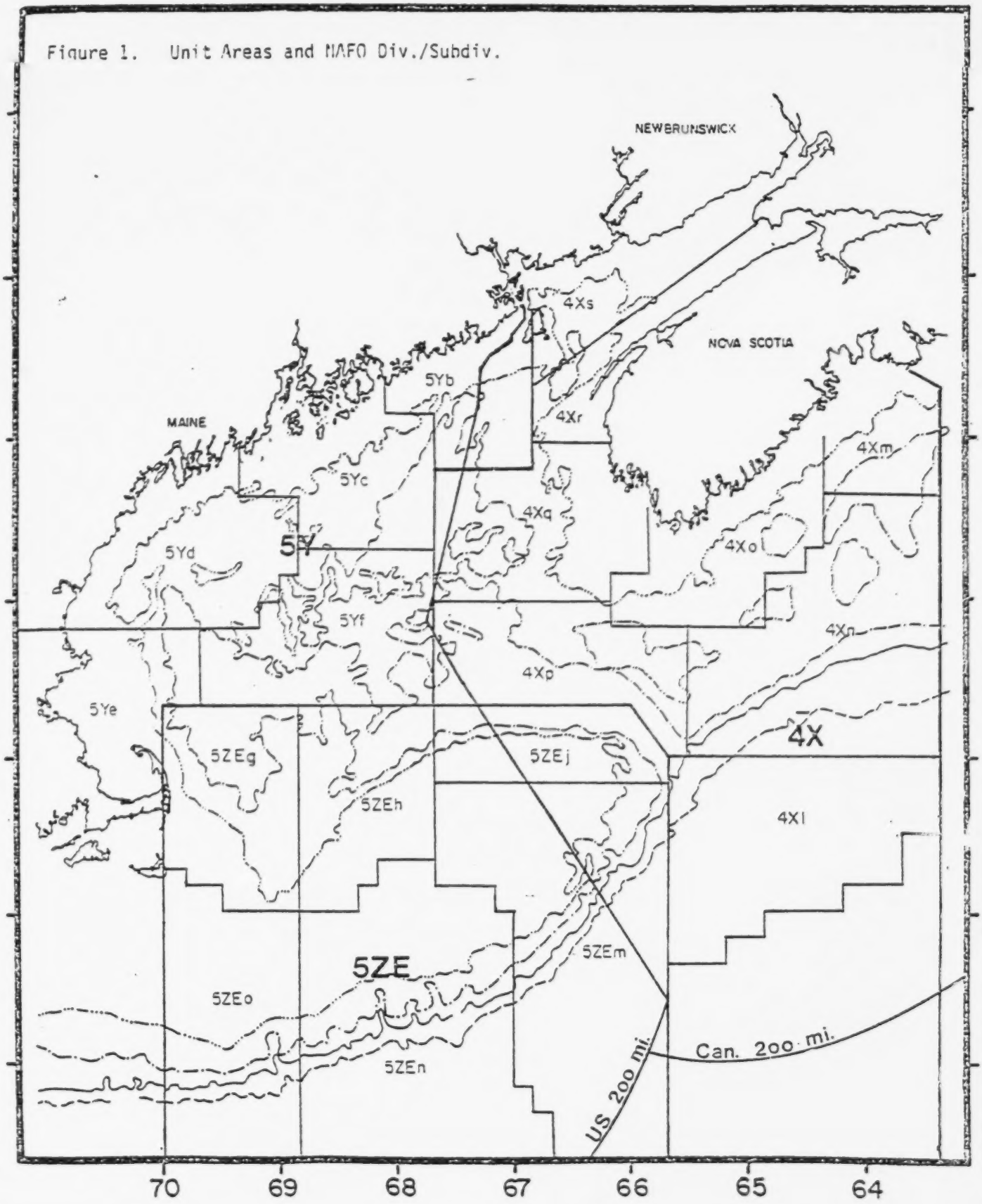
MEAN WEIGHT OF INDIVIDUALS IN CATCH 86/05/12

	1985	1986	1987
	2.5	2.5	2.7

FISHING MORTALITY 86/05/12

	1985	1986	1987
1	0.000	0.000	0.000
2	0.040	0.035	0.020
3	0.192	0.168	0.096
4	0.280	0.245	0.140
5	0.400	0.350	0.200
6	0.400	0.350	0.200
7	0.400	0.350	0.200
8	0.400	0.350	0.200
9	0.400	0.350	0.200
10	0.400	0.350	0.200
11	0.400	0.350	0.200
12	0.400	0.350	0.200
13	0.400	0.350	0.200
1+	0.140	0.131	0.077

Figure 1. Unit Areas and NAFO Div./Subdiv.



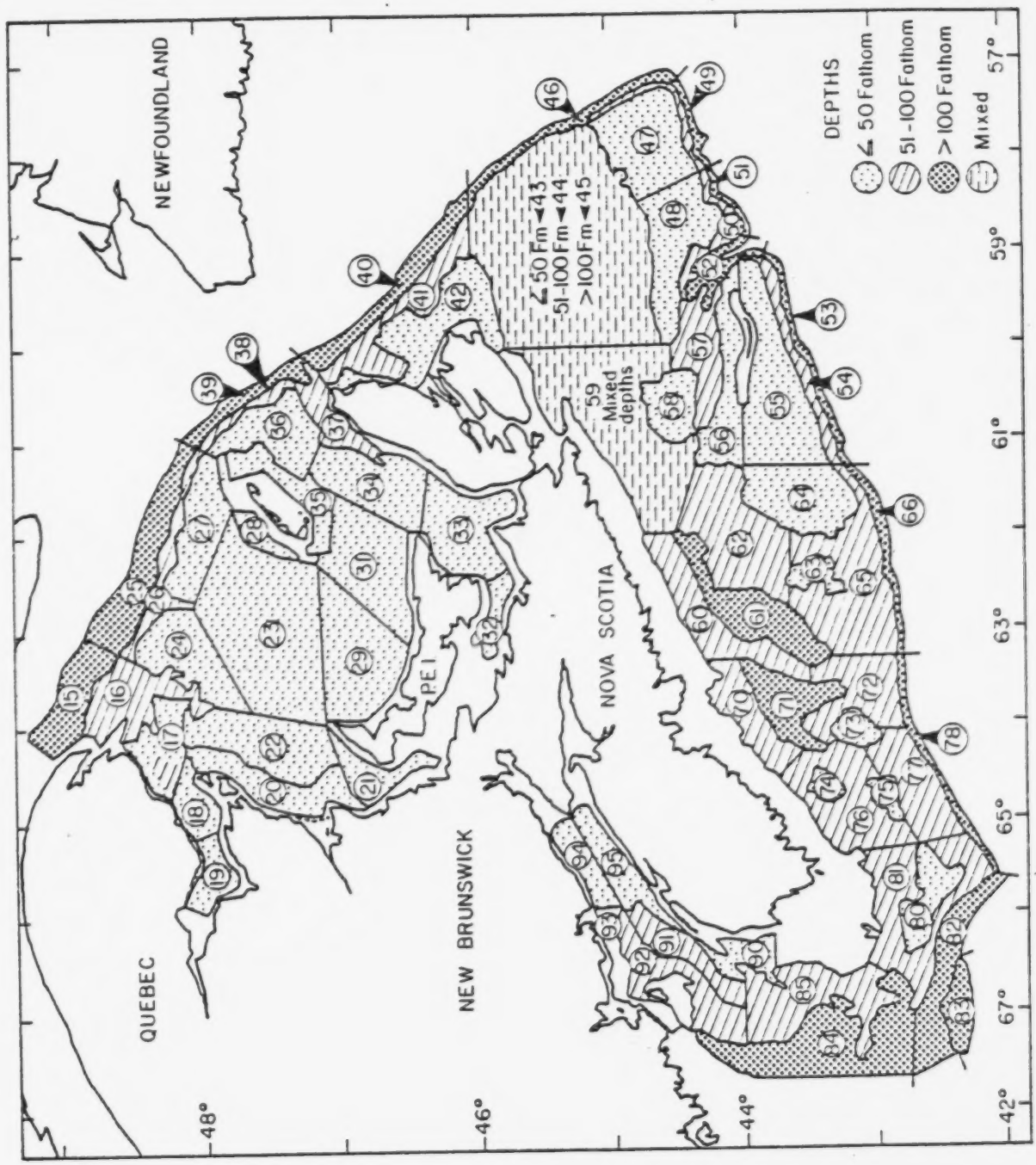


Figure 2. Stratification scheme used for the research groundfish surveys.

Figure 3. Nominal catch (t) of 4X cod between 1948-85.

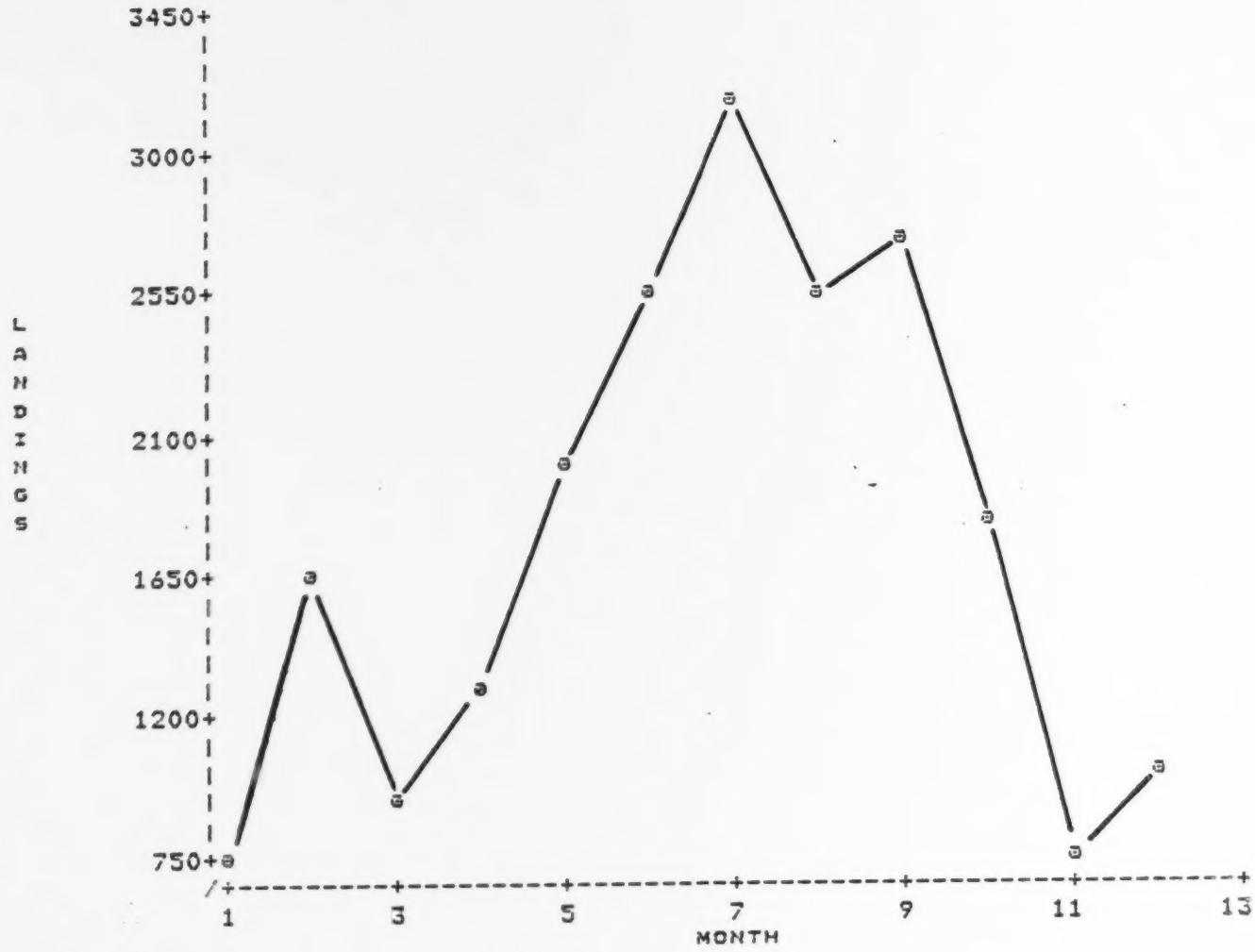
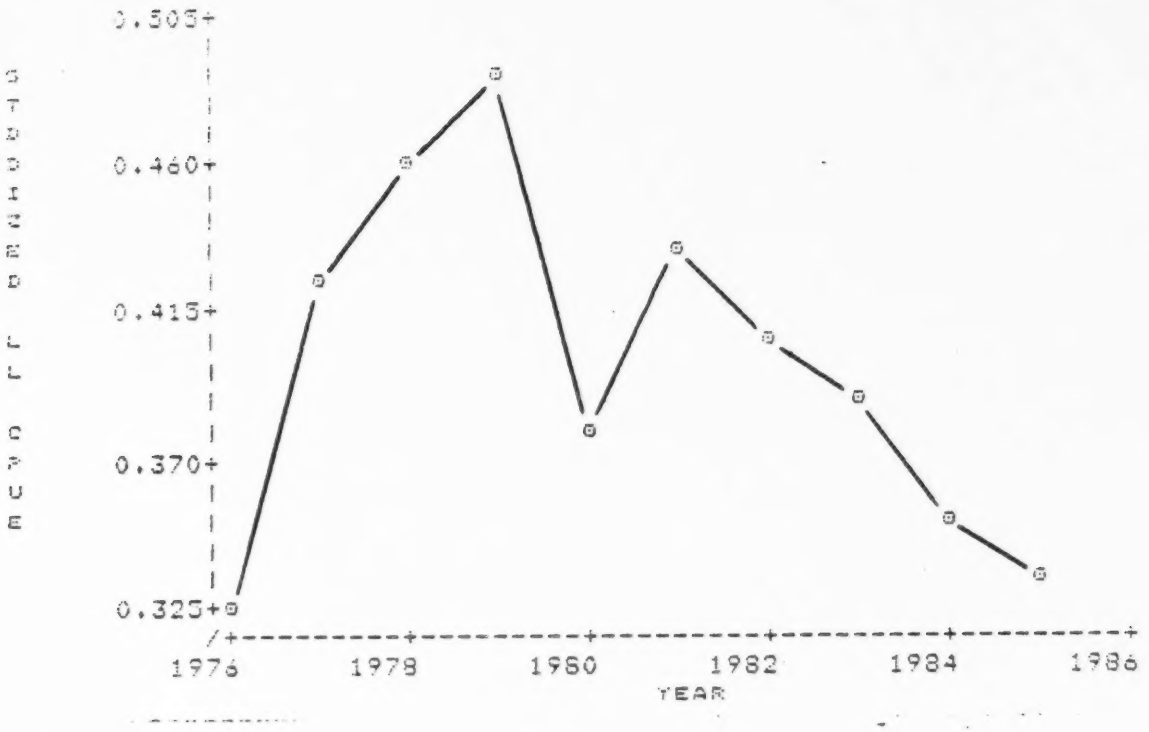


Figure 4. Total landings (t) of 4X cod in 1985 by month.

(A) LL



(B) OT

Figure 5. Standardized commercial catch rates in 4X.

(C) LL and OT

Figure 5. (Continued).

(A) Summer

(B) Beginning of Year

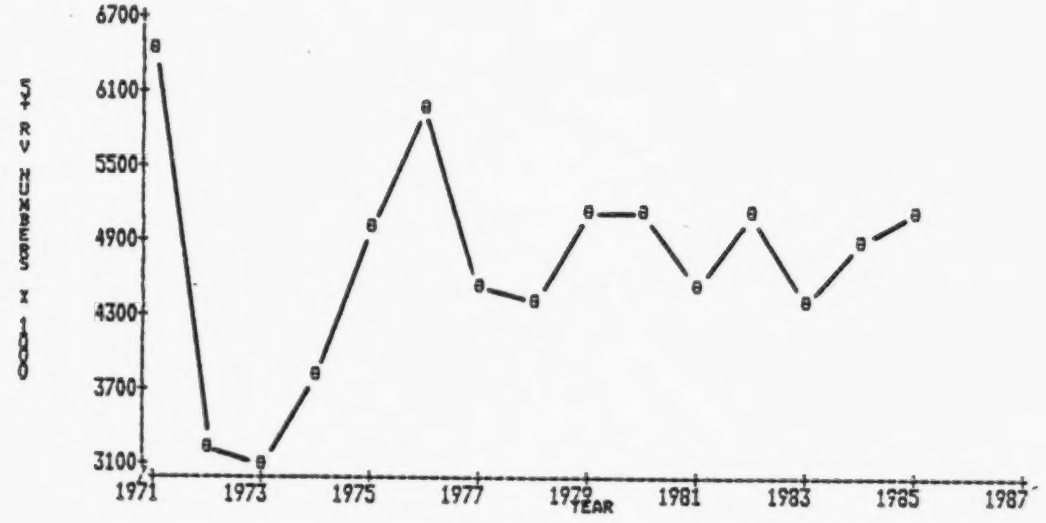
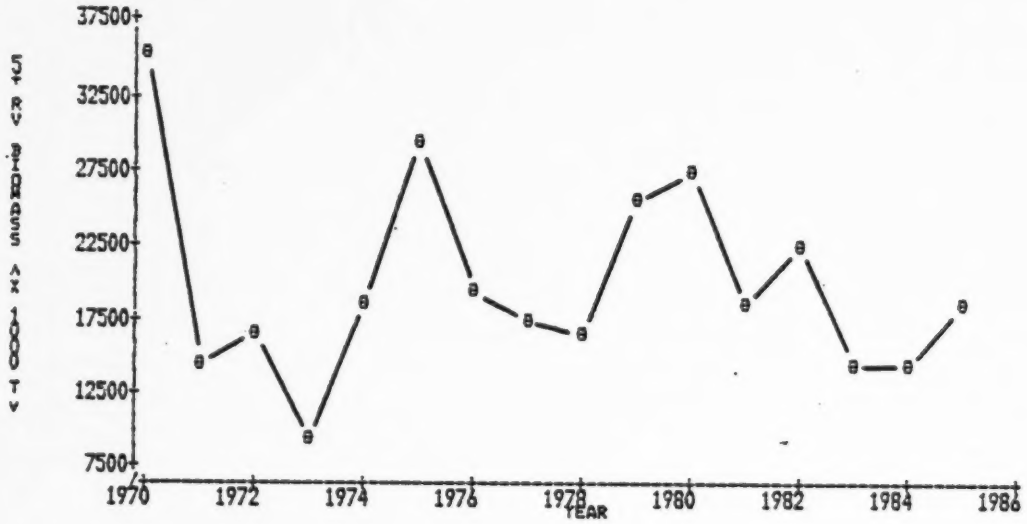


Figure 6. Trends in abundance as determined in RV surveys.

(A) 5+ Biomass



(B) Total Biomass

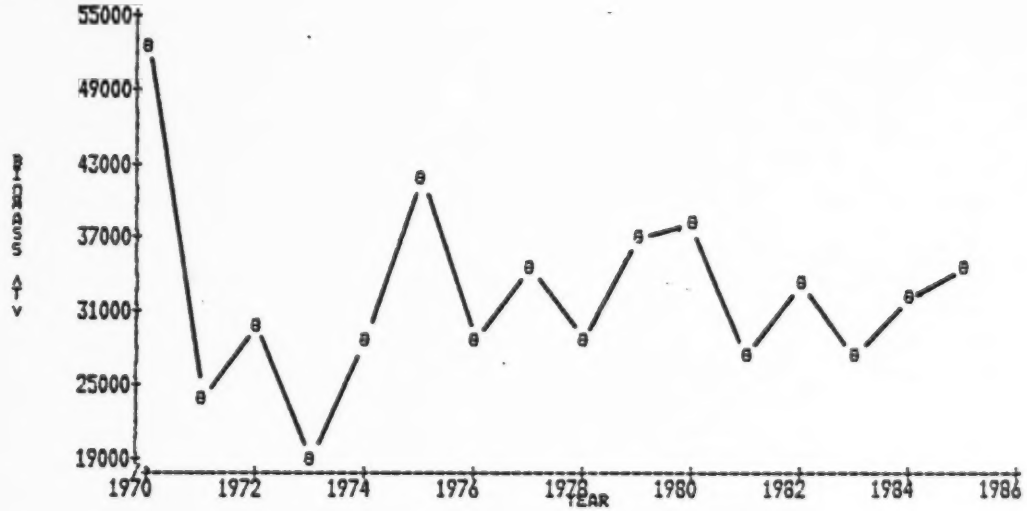


Figure 7. Trends in 4X cod biomass as determined from RV surveys.

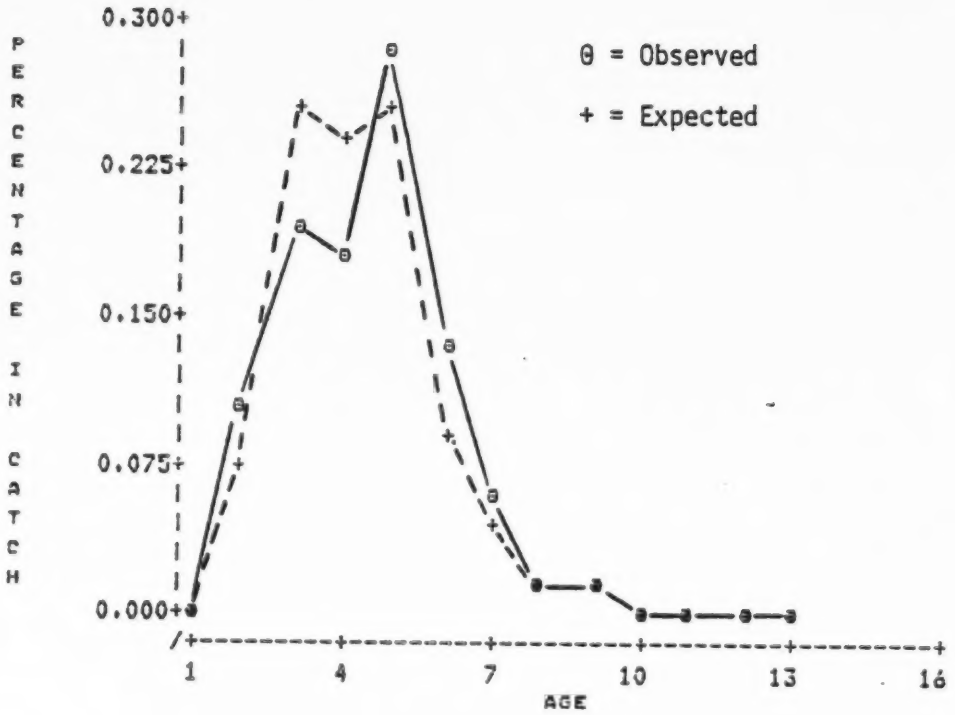
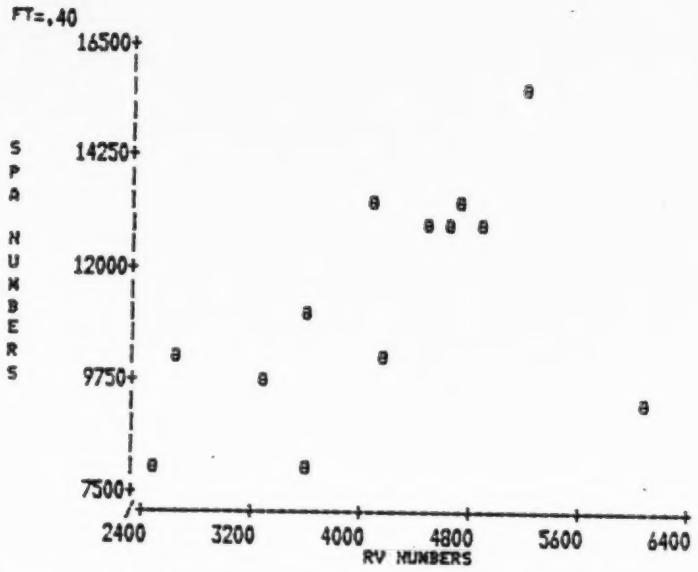


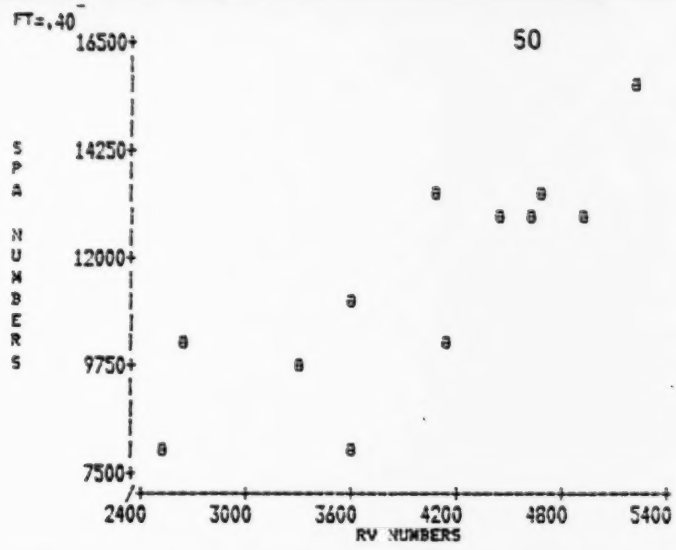
Figure 8. Observed age composition in the 1985 catch compared to that projected in 1984.



YEAR:	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
RV:	2491	4141	3295	3603	6078	4620	4080	4914	4468	2626	4709	4078	4614	5202	3623
SPA:	8115	10033	9839	7735	9175	13037	13279	12948	12679	10094	13182	13311	12807	15627	11319

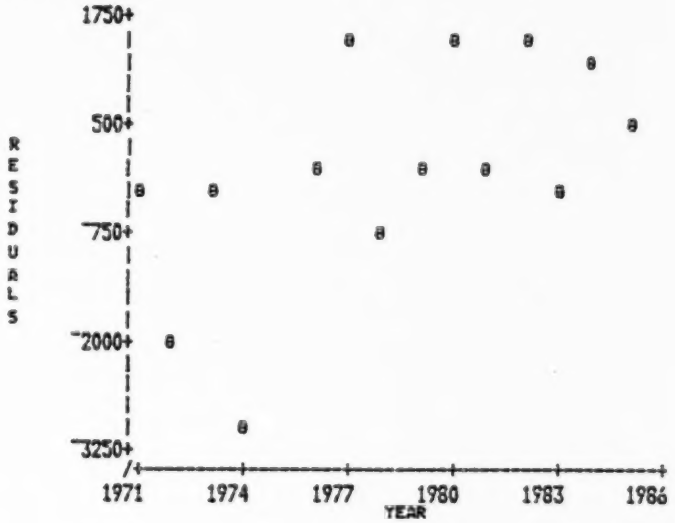
SLOPE IS:
1.161370634
Y INTERCEPT IS:
6702.970585
R2 IS:
0.2375990859
SUM OF RESIDUALS OF LAST 3 YEARS:
4036.478489

Figure 9. Regression of cohort population estimates (ages 4-6) on RV population estimates (ages 4-6) for F_t = 0.40. Note the 1975 outlier.



YEAR:	1971	1972	1973	1974	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
RV:	2491	4141	3295	3603	4620	4080	4914	4468	2626	4709	4078	4614	5202	3623
SPA:	8115	10033	9839	7735	13037	13279	12948	12679	10094	13182	13311	12807	15627	11319

SLOPE IS:
2.2344426
Y INTERCEPT IS:
2702.771543
R2 IS:
0.6637073677
SUM OF RESIDUALS OF LAST 3 YEARS:
2027.788591



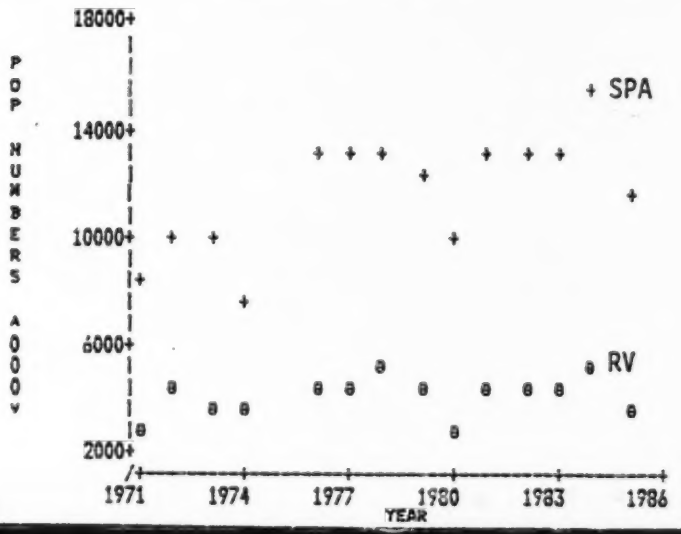
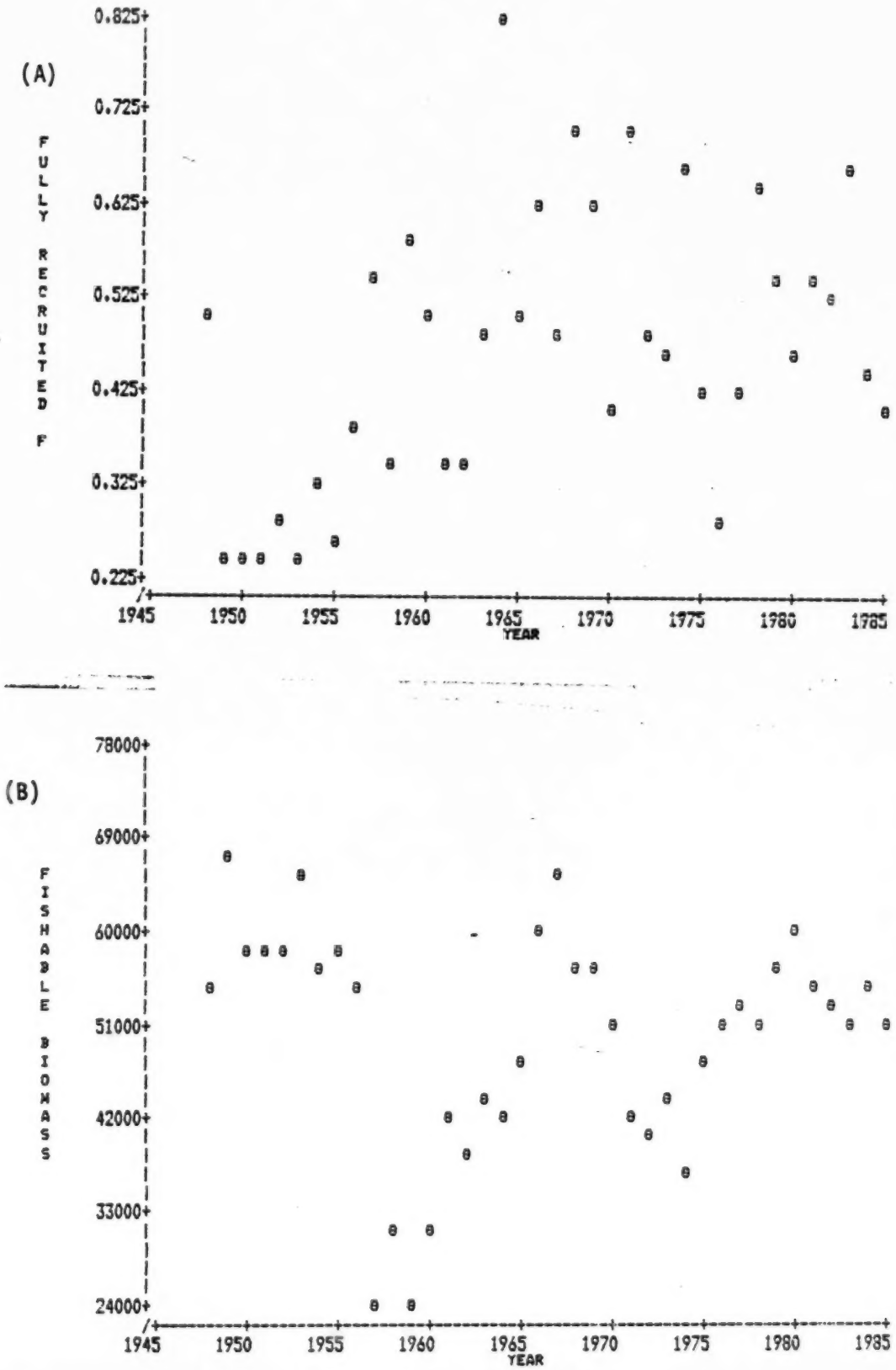


Figure 10. Regression of cohort population estimates (ages 4-6) at F_t=0.40 on RV population estimates (ages 4-6) with 1975 outlier removed.

Figure 11. Historic estimates of: (A) fully recruited F (age 6+) and (B) fishable biomass. F_t was set at 0.40.



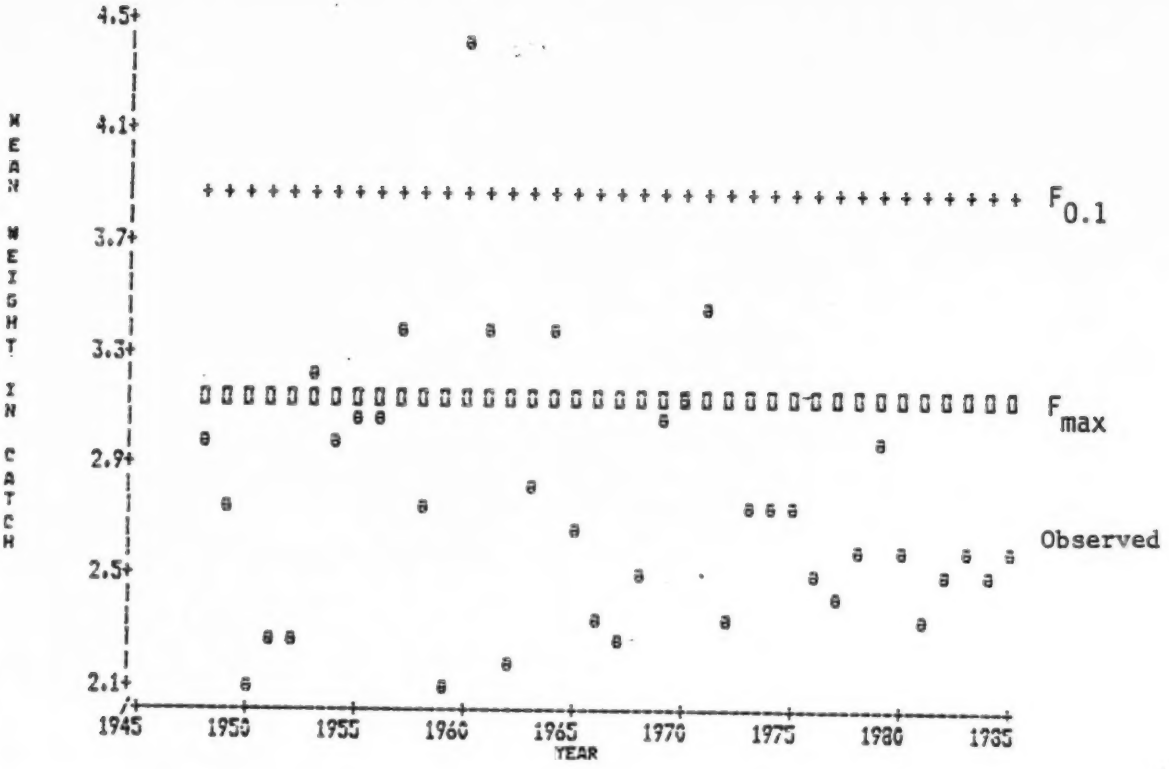


Figure 12. Observed and expected mean weight (kg) in catch.

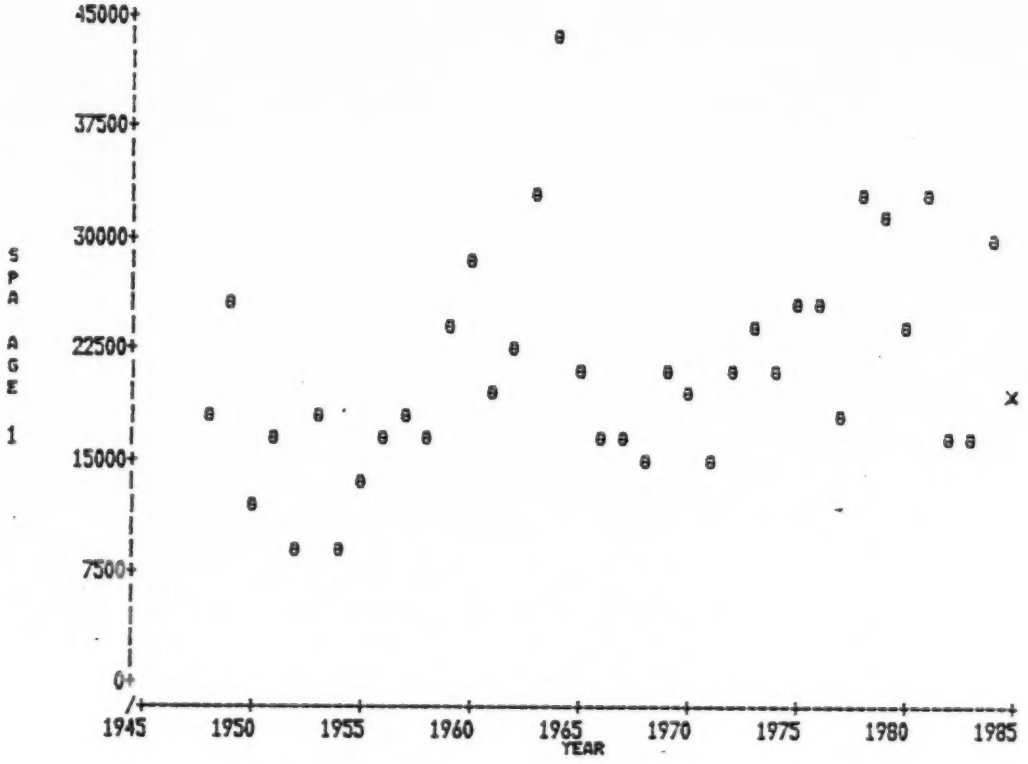


Figure 13. Recruitment time series (age 1) for 4X cod as estimated from cohort analysis. Value for 1985 (X) is geometric mean of previous years.

Appendix

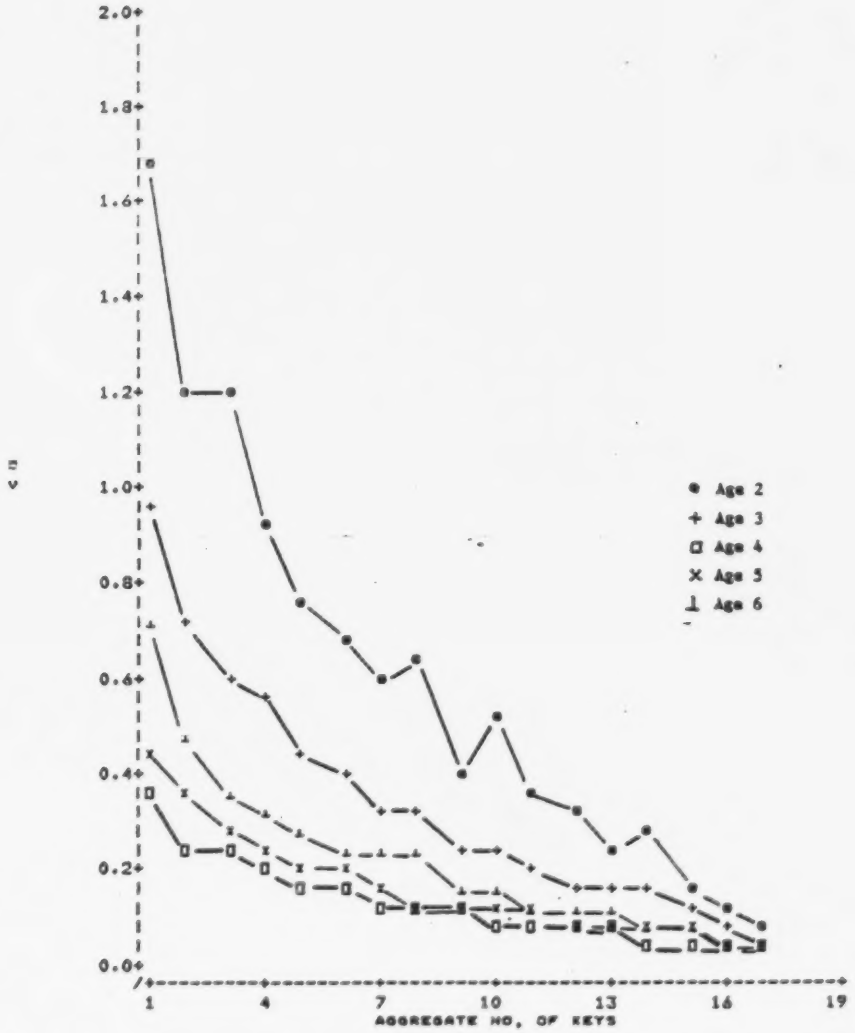
The 4X cod catch-at-age matrix was extended back to 1948 with the knowledge that sampling intensity varied yearly. Total yearly samples ranged between a high of 59 and a low of 2 (Table 8). Under ICNAF sampling recommendations of one sample/1000 t, yearly samples should have ranged between 12-33. Clearly, some years were undersampled.

There is no a posteriori technique to determine if sampling in a poorly-sampled year was adequate. However, the adequacy of sampling intensity can be inferred through Monte Carlo subsampling of well-sampled years. This is the technique that was adopted for this study. Through assessment of the influence of sample number on variability in percent composition-at-age, subjective decisions as to minimum sample requirements were made. These requirements were then assumed to be representative of sampling requirements in other years.

The influence of sample number on variability in mean age composition was determined through jackknife estimations of percent composition-at-age. Variability was assessed through coefficients of variation (CV)-at-age. A well-sampled "base year" was selected at random from those years with more than 15 samples; the year selected, 1978, appeared to be representative of other years in the fishery in that the catch was largely split between OTs and LLs. Sampling in 1978 consisted of 9 LL, 8 OT, and 1 GN sample for a total of 18.

The simulation model was run at all subsample levels between 1-18. During each run, the specified number of samples was selected randomly, without replacement, from the 18 available. A mean age composition was then calculated and the procedure repeated 100 times. Final output was the CV of percent composition for the major ages in the fishery (ages 2-6).

As would be expected, age composition CV decreased with sample number and was lowest for the most abundant ages in the fishery. CVs for ages 4-6 remained at relatively low levels for sample aggregates greater than 3; those for ages 2 and 3 required 13 and 9 samples, respectively, to achieve comparable levels. Thus, large sample numbers were most effective in reducing the variance of the ages least represented in the catch. Given the convergent properties of an SPA, the variance of ages 4-6 should be of primary concern when assessing the adequacy of sample numbers. These results suggest that sample sizes of 3-5 will reduce CV at ages 4-6 to 20-30%, a level that could be interpreted as being minimally adequate. Given the fact that 76% of the years in the time series 1948-85 were represented by 6 or more samples, and given the sporadic nature of the poorly-sampled years, we deemed the time series adequate for reconstruction by SPA.


2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
4
7
10
13
16
19
AGGREGATE NO. OF KEYS
Age 2
Age 3
Age 4
Age 5
Age 6